REPORT

ON THE

PROGRESS OF AGRICULTURE IN INDIA

FOR

1917-18

00134317

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1919

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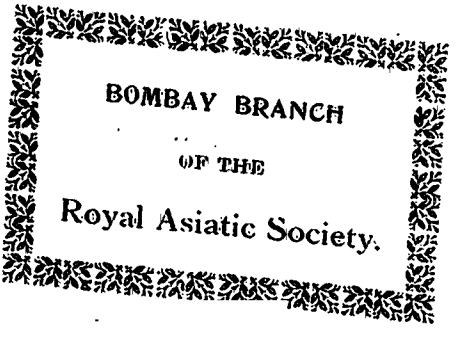

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HIS EXCELLENCY THE VICEROY AND THE STAFF OF THE PUSA INSTITUTE.

Standing : Mr. A. Howard, C.I.E.; Dr. W. H. Harrison ; Mr. W. A. Davis ; Lord Carnegie (A. D. C.) ; Mr. C. M. Hutchinson ; Dr. F. J. F. Shaw ; Mr. Wynne Sayer ; Mr. T. Bainbrigge Fletcher.

Sitting : Mrs. G. L. C. Howard ; Sir Claude Hill, K.C.S.I.; His Excellency the Viceroy ; Mr. J. Mackenna, C.I.E.; Dr. E. J. Butler.
Mr. F. M. Howlett. Captain Hodgkinson, R.E.

TABLE OF CONTENTS.

	Page
Introduction	vii
Chapter I.—Progress in Administration—	
(*a*) The Agricultural Adviser	1
(*b*) War Services of the Staff	2
(*c*) Changes in the personnel of the staff	5
(*i*) The Pusa and Muktesar Staff	*ib.*
(*ii*) The Staff in the Provinces	6
(*d*) Conferences	9
Chapter II.—Progress in Scientific Research—	
(*a*) Agriculture and Botany	11
Wheat	13
Rice	17
Cotton	23
Sugarcane	31
Jute	42
Indigo	46
Tobacco	50
Oil-seeds	52
(*i*) Linseed	*ib.*
(*ii*) Groundnuts	*ib.*
(*iii*) Sesamum	53
(*iv*) Coconuts	54
Tea and Coffee	55
Rubber	57
Fruit	*ib.*
Fodder Crops and Grasses	60
Miscellaneous	63
(*b*) Agricultural Chemistry	66
Soils	*ib.*
Manures	69
Sugarcane	73
Indigo	74
Dairying	75
Miscellaneous	*ib.*

	PAGE
(*c*) Mycology and Plant Pathology	78
Diseases of paddy	79
Black band disease of jute	81
Diseases of palm trees	82
Diseases of tea and coffee	83
Diseases of rubber	*ib.*
Miscellaneous	84
(*d*) Entomology	85
Cotton pests	86
Rice pests	87
Sugarcane pests	88
Tea and Coffee pests	89
Orchard and Garden Pests	90
Insect Pests of Stored Grain	91
Lantana	*ib.*
Protection of wood against termites	92
Miscellaneous	93
Useful Insects	94
(*i*) Silkworms	*ib.*
(*ii*) Lac	98
(*e*) Pathological Entomology	99
(*f*) Agricultural Bacteriology	100
(*i*) Soil biology	101
Nitrification	*ib.*
Nitrogen fixation	*ib.*
Green-manuring	*ib.*
Phosphate requirements of soil bacteria	102
(*ii*) Indigo	103
(*iii*) Pebrine	104
(*iv*) Miscellaneous	106
(*g*) Agricultural Engineering	107
Power pumping	108
Well-boring	109
Steam ploughing	112
Mechanical power for other agricultural purposes	113
CHAPTER III.—PROGRESS IN DEMONSTRATION AND CO-OPERATION—	
(*a*) Demonstration	114
Progress in—	
(*i*) Bombay	115

	PAGE
(*ii*) Madras	117
(*iii*) Bengal	119
(*iv*) Bihar and Orissa	121
(*v*) United Provinces	122
(*vi*) Punjab	123
(*vii*) Burma	124
(*viii*) Central Provinces	125
(*ix*) Assam	127
(*x*) North-West Frontier Province	128
(*xi*) Mysore	*ib.*
(*xii*) Travancore	129
(*xiii*) Baroda	130
(*b*) Co-operation	*ib.*
General	*ib.*
Progress in—	
(*i*) Bombay	134
(*ii*) Madras	136
(*iii*) Bengal	138
(*iv*) Bihar and Orissa	139
(*v*) United Provinces	140
(*vi*) Punjab	141
(*vii*) Burma	142
(*viii*) Central Provinces	144
(*ix*) Assam	145
Co-operative Dairies	*ib.*
Cattle Insurance	148
CHAPTER IV.—PROGRESS IN AGRICULTURAL EDUCATION	151
Introduction	*ib.*
Agricultural Colleges in the Provinces—	
(*i*) Poona	153
(*ii*) Coimbatore	*ib.*
(*iii*) Nagpur	154
(*iv*) Sabour	155
(*v*) Cawnpore	*ib.*
(*vi*) Lyallpur	156
Agricultural education in Burma	*ib.*
Agricultural Schools in Mysore	*ib.*
Post-graduate agricultural education	157

	Page
Vernacular agricultural and rural education . .	157
(*i*) Two years' vernacular course at Cawnpore	*ib.*
(*ii*) Vernacular class at Lyallpur . . .	158
(*iii*) Vernacular Agricultural Middle Schools .	159
(*iv*) Rural Science classes in Mysore . .	160
(*v*) Agricultural Night School in Travancore .	*ib.*
Demonstration as a form of education . . .	*ib.*
Chapter V.—Progress in Veterinary Work	162
1. Administrative changes and health of stock in—	
(*i*) Bombay	*ib.*
(*ii*) Madras	163
(*iii*) Bengal	164
(*iv*) Bihar and Orissa	165
(*v*) United Provinces	*ib.*
(*vi*) Punjab	166
(*vii*) Burma	167
(*viii*) Central Provinces	168
(*ix*) Assam	169
(*x*) North-West Frontier Province . .	170
(*xi*) Sindh, Baluchistan and Rajputana .	171
(*xii*) Imperial Bacteriological Laboratory .	*ib.*
2. Preventive inoculation and legislation . . .	173
3. Cattle-breeding	177
4. Sheep-breeding	184
5. Veterinary education	188
6. Veterinary research	189
Chapter VI.—Publications	193
Imperial	*ib.*
Provincial	*ib.*
Chapter VII.—Expenditure	196
Appendix I.—List of Agricultural Stations in British India.	199
Appendix II.—Operations of Non-credit Agricultural Co-operative Societies in British India during 1917-18.	206
Appendix III.—List of Agricultural Colleges and Schools in British India.	210

		Page
Appendix IV.	Table showing the working of the Provincial Civil Veterinary Departments during 1917-18.	216
Appendix V.	Table showing details as to students of Veterinary Colleges and Schools in India during the year 1917-18.	217
Appendix VI.	List of Agricultural Publications in India during 1917-18.	218

INTRODUCTION.

THIS report furnishes a general review of the progress made in agriculture and allied subjects during the year 1917-18. In spite of the large depletion of staff due to the war the activities of the department have not been curtailed to the extent which might have been anticipated. With the cessation of hostilities, however, it is hoped that it will be possible to recruit much more staff and to embark upon schemes of development which have been held in abeyance for lack of men and money.

I would again repeat that, as regards the more scientific sections, the reading public must make their choice of the sciences in which they are particularly interested. The reports of scientific work must of necessity be couched in technical language and may appear somewhat dull to the general reader who has no first hand knowledge of the subjects discussed. It is hoped, however, that the report as a whole will prove of sufficient interest to the general reading public.

I have again to express my thanks to Mr. Wynne Sayer, Assistant to the Agricultural Adviser, who has continued to give me valuable assistance both in the general work of my office and in the compilation of this report.

J. MACKENNA,
Agricultural Adviser to the Government of India.

CAMP SABOUR,
January 22, 1919.

Report on the Progress of Agriculture in India for 1917-1918.

CHAPTER I.

PROGRESS IN ADMINISTRATION.

(*a*) The Agricultural Adviser.

I held charge of the office of Agricultural Adviser to the Government of India throughout the year. From the 8th of October, 1917, I also acted as President of the Indian Cotton Committee in addition to my own duties. Mr. Wynne Sayer held the post of Assistant to the Agricultural Adviser during the year, except for a month from 3rd September, 1917, when he was on privilege leave.

Tours. From the beginning of October till the end of March I was continuously on tour in connection with the Indian Cotton Committee. This enabled me to see many of the farms and to meet practically all the staff of the Agricultural Departments in the Punjab, the United Provinces, the Central Provinces, Bombay (including Sind) and Madras, as also Central India, Hyderabad and Baroda. Other tours of the year were a short visit to the Central Provinces in August and one to Cawnpore in connection with Messrs. Leake and Annett's opium work. In November I attended and addressed the Chiefs' Conference at Delhi, and in December presided over the meetings of the Board of Agriculture at Poona. At the beginning of May I visited Bombay in connection with various cotton trade questions.

During the course of the year a few visits were paid to Muzaffarpur, where I attended the meetings of the Bihar Planters' Association in connection with the indigo question.

(*b*) War Services of the Staff.

In common with other departments of Government, the Agricultural Department has been profoundly affected by the war. Large numbers of its officers have joined the Army. Two of its most promising members—Messrs. Woodhouse and Southern—have laid down their lives for their country, while several members of the Service have been wounded.

Recruitment has been practically at a standstill and the work of the department has been kept going by heavily depleted staffs. In consequence it has not been possible to initiate new lines of work. But with the altered conditions, it is hoped rapidly to make up the lee-way and to recruit suitable men for posts already sanctioned but unfilled. There are many pressing problems which call for investigation and for which it is hoped that men and money will now be available.

The following officers of the Agricultural and Veterinary Departments were on military duty or war work during the year.

Imperial Department of Agriculture in India. Mr. J. H. Walton, Supernumerary Agricultural Bacteriologist, continued in the Indian Army Reserve of Officers which he joined in June, 1915. In February, 1918, Mr. G. S. Henderson, Imperial Agriculturist, was deputed to Mesopotamia to examine the agricultural conditions there, and since his return to India he has been appointed Controller for Agricultural Requirements, Mesopotamia, under the Indian Munitions Board.

Imperial Bacteriological Laboratory, Muktesar. Mr. A. W. Shilston went, in June, 1917, on deputation to Basra, to investigate lymphangitis simulating glanders among horses and also biliary fever, and returned to India in October. Dr. R. V. Norris reverted from military duty and was appointed Agricultural Chemist to the Government of Madras.

Provincial Agricultural and Veterinary Departments. Bombay. Dr. W. Burns, Economic Botanist, and Mr. T. Gilbert,

PLATE I.

THE LATE LIEUT. E. J. WOODHOUSE, M.A., DIP. in AGRI. (CANTAB), F.L.S.

Dulce et decorum est pro patriâ more.

Deputy Director of Agriculture, continued on military duty throughout the year. Mr. Hewlett, Principal, Veterinary College, Bombay, held the appointment of Deputy-Assistant Director, Veterinary Services (Embarkation), Bombay, with the rank of Major. Mr. Sowerby, the Assistant Principal, who holds a commission as Major in the Bombay Garrison Artillery, was in command of a Sub-district of the Bombay Coast Defences for three months and for the remainder of the year commanded his company. He assisted Major Hewlett in his embarkation duties.

Madras. Mr. E. Ballard, Government Entomologist, who joined the army in England in February, 1916, remained on military duty throughout the year. Mr. Roger Thomas, Deputy Director of Agriculture, was deputed as Cotton Expert under the Political Resident, Mesopotamia.

Bengal. Mr. K. McLean, Deputy Director of Agriculture, Eastern Circle, and Messrs. P. J. Kerr (now Captain) and A. D. MacGregor, of the Civil Veterinary Department, continued on military duty throughout the year.

Bihar and Orissa. Lieutenant E. J. Woodhouse, Principal of the Sabour Agricultural College, who joined the Indian Army Reserve of Officers in 1915, died of wounds in France on the 18th December, 1917. By his untimely death the department has lost a most capable officer and one whom it will be difficult to replace. Mr. (now Captain) G. C. Sherrard, Deputy Director, whose services were placed at the disposal of the Army Department to improve the supply of vegetables in Mesopotamia, has returned to India and has been appointed Deputy Controller for Agricultural Requirements, Mesopotamia, under the Indian Munitions Board, with effect from 1st July, 1918. He has been mentioned in despatches twice. Mr. N. S. McGowan who had been badly wounded has been invalided out of the service and has resumed charge of his duties as Professor of Agriculture, Sabour College.

United Provinces. Dr. A. E. Parr and Mr. W. N. Harvey, Deputy Directors of Agriculture, continued on military duty. The former officer has been wounded twice. Mr. G. Clarke was invalided from military service in Europe and resumed

charge as Agricultural Chemist. Mr. B. C. Burt, Deputy Director of Agriculture, was on special duty under the War Board, United Provinces, from 19th September to 22nd December, 1917, in connection with fodder supply for the Military Department. During the year, Mr. S. G. M. Hickey, Second Superintendent, Civil Veterinary Department, joined the Indian Army Reserve of Officers.

Punjab. Mr. H. Southern, Deputy Director of Agriculture, who joined the Indian Army Reserve of Officers in March, 1915, is now reported as dead. By his death the department has been deprived of a capable and popular young officer. Messrs. D. Meadows and W. A. Pool, of the Civil Veterinary Department, remained on military duty. Mr. H. E. Cross, Camel Specialist, was temporarily transferred to the Army Department with effect from the 15th June, 1917.

Burma. Mr. T. Couper, I.C.S., Director of Agriculture, joined the Indian Army Reserve of Officers in May, 1918. The services of Mr. E. Thompstone, Deputy Director, were placed at the disposal of the Army Department from 1st May to 26th July, 1918. Mr. F. J. Warth, Agricultural Chemist, was appointed Assistant Commandant of Military Police in March but reverted in May, 1918. Major Rennie, Second Superintendent, Civil Veterinary Department, has joined the Royal Artillery (Indian Defence Force) and Mr. C. J. N. Cameron continued on military duty.

Central Provinces. Messrs. R. H. Ritchie and F. J. Plymen remained on military duty. During the year Mr. (now Colonel) G. Evans was appointed Director of Agriculture, Mesopotamia. Dr. Graham, Economic Botanist, who joined military duty in November, 1917, has been posted to the Agricultural Department in Mesopotamia.

Assam. Mr. A. G. Birt, who joined the Indian Army Reserve of Officers in May, 1915, continued on military duty.

During the year under report a total number of six Veterinary Inspectors and 89 Veterinary Assistants were on military duty.

Besides the above, Mr. G. Milne, Director of Agriculture, has been appointed Director of Civil Supplies, Bihar and Orissa, in addition to his own duties. He is also Custodian of Enemy Property.

The following officers were appointed to serve on the Food-stuffs Sub-Committee of the Central Transport and Food-stuffs Board formed at the head-quarters of the Government of India :

(1) Mr. J. Mackenna, C.I.E., I.C.S., Agricultural Adviser to the Government of India.

(2) Mr. E. A. A. Joseph, I.C.S., Director of Agriculture, Punjab.

(3) Mr. G. S. Henderson, Imperial Agriculturist, Pusa.

The names of the undermentioned officers were brought to the notice of the Government of India for valuable services rendered in India in connection with the war up to the 4th August, 1917 :—

(1) Mr. J. Mackenna, C.I.E., I.C.S., Agricultural Adviser to the Government of India and Director, Agricultural Research Institute, Pusa.

(2) Mr. D. A. D. Aitchison, M.R.C.V.S., Principal, Madras Veterinary College.

(3) Mr. K. Hewlett, M.R.C.V.S., Principal, Bombay Veterinary College and Hospital.

(4) Colonel J. Farmer, C.I.E., Chief Superintendent, Civil Veterinary Department, Punjab.

(*c*) Changes in the Personnel of the Staff.

Very few changes in the *personnel* have taken place during the year under report. Such as have occurred, have been occasioned by the deputations on military duty referred to above. The depletion of superior staff thus caused has been met either by doubling up charges or by promoting Indian Assistants to temporary charge. The promotion of these Assistants in temporary vacancies has given us an opportunity of gauging their fitness for independent charge.

(*i*) *The Pusa and Muktesar Staff.*

Dr. W. H. Harrison, who was selected to succeed the late Dr. J. H. Barnes as Imperial Agricultural Chemist, joined his new

appointment in November, 1917. Mr. F. M. Howlett, Imperial Pathological Entomologist, returned from leave in August, 1917. Mr. Wynne Sayer, Assistant to the Agricultural Adviser, has been placed in charge of the work of the Imperial Agriculturist in addition to his own duties since the departure of Mr. Henderson on deputation to Mesopotamia.

Proposals are under consideration to bring the post of Physiological Chemist at Muktesar under reduction and to recruit in the vacancy thus caused a veterinary officer with some agricultural experience who would be able to take over the management of the large estate attached to the laboratories. Dr. Macalister has resigned the post of Pathologist which remains vacant.

(*ii*) *The Staff in the Provinces.*

In Bombay, three of the four permanent Deputy Directors were again absent on other duty throughout the year, and the Agricultural Engineer had to devote much of his time to work in connection with the Munitions Board. Several junior members of the staff again left the department to take up more lucrative appointments in other parts of India and the demand for them is such that the department finds much difficulty in securing the men it needs.

In Madras, Mr. J. C. Razu has been appointed Deputy Director of Agriculture. Dr. Marsden, the Dyeing Expert, was deputed to investigate the condition of the Madras indigo industry during the year under report. The post of Government Entomologist, sanctioned in the first instance for five years only, has now been made permanent, while sanction has also been accorded to the continuance of the Sugarcane-breeding Station at Coimbatore for another five years.

In Bengal, Mr. S. Milligan has been confirmed as Director of Agriculture. Mr. G. P. Hector, Economic Botanist, returned from leave in October 1917. Mr. Annett, the Bengal Agricultural Chemist, remained on deputation in connection with the improvement of the morphine content of Indian poppy Babu R. D. Gupta has been appointed to officiate as Deputy Director in the vacancy caused by Mr. McLean's deputation to

military duty. The staff of District Agricultural Officers has been strengthened and now numbers seventeen.

In Bihar and Orissa, Mr. C. S. Taylor, Agricultural Chemist, has been confirmed as Principal of the College at Sabour. The post of Economic Botanist rendered vacant by the lamented death of Mr. Woodhouse has not yet been filled.

In the United Provinces, Mr. A. W. Fremantle, formerly Principal of the Cawnpore Agricultural College, has retired from the service. Mr. G. Clarke, Agricultural Chemist, returned to India in November, 1917. Mr. W. Youngman of the Canning College, Lucknow, has been appointed Assistant Economic Botanist. It is proposed to extend the period of appointment of Mr. Hulme as Sugar Engineer for another season.

In the Punjab Mr. E. A. A. Joseph, I.C.S., succeeded the Hon'ble Mr. Townsend, I.C.S., as Director of Agriculture towards the end of the year. Mr. Roberts, Principal of the Lyallpur Agricultural College, was on deputation with the Indian Cotton Committee of which he was a member, and in his place Mr. Wilsdon, Agricultural Chemist, acted as Principal. His work as Professor of Agriculture was performed by Mr. O. T. Faulkner. In view of the affiliation of the college to the Punjab University, the college staff has been strengthened by the addition of three new Assistant Professors and three Demonstrators. On the question of staff the Director remarks as follows (and these remarks apply with equal force to all other provinces) :—

" The question of staff, both superior and subordinate, is one which limits the expansion of the department's energies at every turn. More Deputy and Assistant Directors are needed and until we can expand our cadre of Agricultural Assistants (at present the sanctioned scale is below strength) it is impossible to develop District Board farms or expand further in any direction. This is a point which is to be borne in mind in dealing with applications for assistance from outside the province, whether from Mesopotamia, from Indian States or elsewhere."

The need for this expansion is especially great in the Punjab in view of the very valuable work done by the department in connection with the spread of American cotton and the sub-

stitution of better yielding varieties of wheat for those usually grown by the cultivators.

In Burma, Mr. English, C.I.E., I.C.S., took over the duties of the Director of Agriculture in addition to his own duties as Director of Recruiting when Mr. T. Couper proceeded on military service in May. During Mr. Thompstone's absence on military duty, Mr. Warth, Agricultural Chemist, held charge of the Northern Circle. Owing to the shortage of officers in the Public Works Department, Maung Ba Gyaw, the temporary Agricultural Engineer, was retransferred to his own department in May, 1918. The post of Third Deputy Director, sanctioned in 1915, as also that of Economic Botanist remain as yet unfilled. A large development of the department involving a re-organization of the staff is now under consideration.

In the Central Provinces, Mr. D. Clouston officiated as Director of Agriculture throughout the year, and also held charge of the Western and Southern Circles for some time. Mr. C. Mayadas was appointed as Assistant Director in September, 1917. The posts of Agricultural Chemist and Economic Botanist, rendered vacant by the deputation of the officers in charge to military duty, were filled by the First Assistants in the sections. During the year three new posts of Extra Assistant Directors were filled. The Director remarks that the administration of the department for the year under review was a heavy task owing to its having been depleted of the major portion of its superior staff. In 1916 there were in the department three Deputy Directors and one Assistant Director, while three experts were attached to the Agricultural College for teaching and research work. By the end of the year under report there was no Deputy Director left in the department, while on the college staff the Principal alone remained to control the teaching. Despite the fact that the superior staff throughout the year was so small, the department was committed to an exceptionally ambitious programme of work, and much progress has been achieved in opening new cattle-breeding and seed and demonstration farms.

In Assam, Mr. Meggitt, Agricultural Chemist, continued to act for Mr. Birt as Deputy Director of Agriculture, Assam Valley. Four additional Agricultural Inspectors have been

added during the year. The Director again emphasizes the need of more superior staff. "Rice breeding urgently demands the services of a wholetime botanist. Demonstrations cannot be adequately controlled by one Deputy Director, no matter how energetic he may be, and the pity of it is that we want more control now because our staff of Inspectors is new and inexperienced, and the people are still suspicious of efforts to improve them without ulterior motive. Then there is the eternal question of cattle-breeding which will never, in my opinion, be properly tackled until we follow the example of Madras and appoint a wholetime man for it."

Other departments report no change in *personnel* during the year under report.

(*d*) **Conferences.**

The tenth meeting of the Board of Agriculture in India was held at Poona from the 10th to the 15th December, 1917. The Board was honcured by the presence of His Excellency the Governor of Bombay who presided at the opening meeting and gave an address. The attendance of the general public was much larger than on any previous occasion, and non-official members took much part in the discussions. The proceedings of the Board have been published and are available to the public.

In view of the increasing amount of work which comes before the full Board of Agriculture it has been decided that Sectional meetings should be held in years in which the full Board does not meet, and accordingly Sectional meetings dealing with Mycology, Entomology, Chemistry and Veterinary science will be held early in 1919.

Recognizing the general interest which is being taken in agriculture and in the activities of the Agricultural Department, the Government of India have invited Local Governments to consider the advisability of constituting Provincial Boards of Agriculture where agricultural questions of purely local interest can be discussed. In some provinces departmental meetings are already held, but it has been suggested that their scope might be extended and that they might be organized somewhat

on the lines of the Board of Agriculture in India. To these, large landowners, representative agriculturists and others interested in rural development would be invited.

CHAPTER II.

PROGRESS IN SCIENTIFIC RESEARCH.

(*a*) Agriculture and Botany.

The importance of research and experimental work in connection with India's greatest industry, agriculture, cannot be overemphasized. During the twelve years that the reconstituted departments have been in existence much valuable work has been done. Most tangible results have been obtained in the following two directions :—

(1) the improvement of the staple crops of the country by selection and the organized distribution of the improved seed obtained, and

(2) the transfer of the best indigenous methods of cultivation and the best indigenous implements as utilized in certain areas to other more backward parts of the country.

The cultivators have readily taken them up as no extra expenditure or labour is required in giving effect to these improvements. The spread of the selected *roseum* cotton which yields about 25 per cent. more than the mixture previously grown in Berar, of Pusa wheats in Bihar, the United Provinces and parts of the Punjab giving an increased profit of Rs. 15 per acre, of Mr. Hector's pure line rice selection, *Indrasail*, which yields 30 per cent. more than the varieties grown by the ryots, to name only a few instances, has been surprisingly rapid. Plant breeding work in India has been so far mostly confined to selection. Hybridization work is also being done by the Howards on wheat, by Leake on cotton and by Barber on sugarcane, and their work is full of promise. But very soon the isolation of pure races from the mixtures grown by the cultivators will be finished, and it is to hybridization that we shall have to look for results in the future. We shall then want a much larger and better organized research staff for the purpose.

The time has now come when more attention should be paid to the other factors in crop production, namely, proper culti-

vation and scientific manuring. The distribution of improved varieties has prepared the way for improvements in manuring and cultivation. It has given the ryot an incentive to better methods of treating his land by showing him that there are possibilities of increased profit from agriculture outside of those furnished by a rise of prices. The moment it becomes apparent that a crop will repay better soil treatment the question of just what treatment is soundest economically becomes one of first importance. Careful investigation in each distinct tract by thoroughly trained officers filled with a zeal for accurate scientific work is necessary before we can recommend a certain practice with confidence in the result. As to the importance of scientific manuring, in Europe large increases in crops have taken place as the result of judicious use of manures. In India the use of manures pays best on land where an adequate supply of water either by rainfall or irrigation is assured. But in many tracts which are exposed to famine and in dry land cultivation the use of any manures other than farmyard manure is out of the question. This manure too is not sufficient to go round and, as much of the dung is burnt as cakes, the Agricultural Departments are doing most useful work in showing cultivators the best way of conserving the liquid as well as solid droppings of the animals. But as the use of dung for fuel is due to economic conditions the necessity of supplementing the work of the department by the creation of fuel and forest reserves is most urgent. Much scientific and accurate experimental work is also required in connection with the best way of using green manures and the most profitable utilization of oilcakes and mineral manures of the country, such as phosphates.

The summary of the work done by the department during the year will not fail to convince an unprejudiced reader that the department is devoting its attention to increasing the outturn of food crops as well as non-food crops. The work being done on rice, wheat, *jowar* (*A. Sorghum*), *and ragi* (*Eleusine coracana*) is already bearing fruit, while the reclamation of waste or barren lands and the growing of more profitable crops on lands which formerly used to carry only poor crops of some inferior millets, the teaching of proper rotations doing away with the necessity of fallows, the reduction of the seed

rate in the case of paddy and the popularization of organic and phosphatic manures where this crop is cultivated under wet land conditions, the prevention of the attack of smut in *jowar* by steeping the seed in copper sulphate before sowing, and the use of improved implements are already producing remarkable results and will in course of time considerably increase the normal outturn of these crops and improve the economic condition of the cultivators.

As India imports many articles of daily consumption for which she pays by exporting her surplus food, cotton, jute, etc., it is but proper that these latter non-food crops should also receive due attention, and already most substantial results to the credit of the Agricultural Department fall to be recorded under these heads. The great success of Kakya Bombai jute, the strain isolated by Mr. Finlow in Bengal, of the selected *roseum* cotton in Berar, of Company cottons in Tinnevelly, and of 4F American cotton in the Punjab, is so gratifying that it is felt that, given a larger staff for investigation and demonstration, the future for the agriculture of India is bright and full of promise. Each year shows considerable addition to the stock of knowledge of local agricultural and economic conditions acquired by the officers of the department, and the results of this are seen in more intensive and fruitful lines of enquiry taken up.

It is not possible in this report to do full justice to the work done during the year, but it is hoped that as far as possible the main lines of enquiry and the more important results achieved have been dealt with.

Wheat. The total area under this crop rose from 32,940,000 acres in 1916-17 to 35,497,000 acres in the year under report, but on account of unfavourable weather conditions the total yield fell from 10,234,000 tons to 10,174,000 tons. The total quantity exported during the year was 1,454,400 tons which exceeded the pre-war average by 11 per cent. and was valued at Rs. 19,00 lakhs.

Most of the Indian wheats are of low quality and in consequence fetch low prices in the markets of the world. The straw is also weak. The aim of the experiments in wheat-breeding is therefore to combine high grain quality with increased yielding power and a strong straw. In Pusa 12 and Pusa 4 these objects

have to a large extent been attained and about 500,000 acres of these varieties will this year be grown by the cultivators. The increased profit is about Rs. 15 an acre.

In this connection it is interesting to note that at the Sydney Royal Agricultural Show of 1917, Pusa 4 and two other varieties (Pusa 107 and Pusa 110) grown by Mr. J. B. Roach at Gilgandra in New South Wales gained 44 out of 45 points and were awarded the first prize in one of the classes. At the Food Products Exhibition held in Calcutta also Pusa 4 and Pusa 12 gained a special prize.

The Howards have made substantial progress in breeding new varieties. A cross made at Cambridge in 1910, between Pusa 4 and one of the new English wheats, has yielded several promising wheats which will now be tried on a field scale. Three other series of crosses on Pusa 6 are now rapidly becoming fixed and this material is expected both to yield wheats of immediate utility as well as parents for further crosses.

In the United Provinces the work on wheat consists mainly in the systematic introduction of improved varieties (Pusa 4, Pusa 12 and Cawnpore 13) into those parts of the provinces where they have proved definitely superior to *desi* varieties. It is estimated that about a quarter of a million acres were under these wheats last season. In the Central Circle Pusa 12 is being systematically introduced on the alluvial soils of the Doab and Oudh. The demand for this seed was intense in the districts of Etawah and Cawnpore. In Oudh the estimated area under Pusa 12 was one hundred thousand acres and the Talukdars are doing very useful work in growing seed on their private farms and demonstrating its superiority. In the Agra and Meerut Divisions of the Western Circle also this wheat is now widely grown. It is estimated that this *rabi* (winter cropping) season 10 to 12 thousand acres will be sown with seed controlled by the Deputy Director of this Circle.

Mr. Leake is devoting considerable attention to finding a wheat better suited than the Pusa wheats to those parts of the provinces where labour is scarce and a beardless wheat is much subject to depredations of birds. In these areas the crop is often left standing when overripe and some of the grain is lost by shedding. A stronger strawed Muzaffar-

nagar wheat has been isolated, having a definitely larger limit of yield than the weak strawed variety ordinarily grown which, except under exceptionally favourable conditions, lodges with high cultivation. This type has not, however, the same comparative immunity from rust as the Pusa wheats and Cawnpore 13, and endeavours to find a more satisfactory wheat will be continued.

Pusa 4*, which is a rapidly maturing, high quality wheat, is being grown on a large scale in North Bihar.

The introduction of Pusa 12 has made satisfactory progress in the Patna and Bhagalpur Divisions. There is a wide-spread demand for seed, and the activities of the local Department of Agriculture in connection with this crop are mainly directed to the organization of seed supply and the extension of the area under this variety.

The area under pure Punjab 11, a type separated by the Howards at Lyallpur from a local mixture in 1906 and handed over to the Agricultural Department of the province in 1908, is estimated to have more than doubled itself in the canal colonies of the Punjab, having risen from 97,000 acres to 196,480 acres in the year under report. Mr. Roberts also estimates that there are at least another 750,000 acres with not more than 10 per cent. impurity.

There seems reason to think that Mr. Milne's selection 8a may oust Punjab 11, and it will be interesting to see whether in the coming *rabi* it displaces the latter in popularity with the zamindars to whom it is distributed. At Lyallpur, Sargodha and Hansi this wheat gave the best yields. In Hoshiarpur, Jullundur, and Sialkot, Pusa 12 continues to be the most popular wheat and is spreading. It has also been introduced in Sirmur and the Simla hills and is becoming popular in Sind. In the *hariana*† tract opinion is reported to be divided, but on the whole Pusa 12 seems to be preferred for well lands and Punjab 11 for canal irrigation.

The experiments with Pusa 12 and Punjab 11 do not show that the former will do with less water than the latter. If two

* This wheat is also being introduced in Central India as an irrigated crop.
† A large part of the Hissar District with parts of Rohtak.

waterings are available there is no advantage with Pusa 12 which on the contrary is readily attacked by birds, while if a third watering is procurable Punjab 11 gives a higher yield than its rival.

On the Government farm at Tarnab, the Australian variety, Federation, again gave very large yields, averaging 2,624 lb. per acre on twelve acres. In its appearance in the field, in actual yield and the quality of its grain, it was all that could be desired. Pusa 4 and Cawnpore 13 came next in order. Federation has been distributed in the Kurram valley and it may become the leading wheat on the more fertile irrigated land there. It may however be mentioned that Federation wheat has not yet proved suitable for *do-fasli* (double) cropping. It requires good cultivation, while in the North-West Frontier Province wheat is sown with little preparatory cultivation directly maize is taken off the land in October. Pusa 4, while it yields best on good *ek-fasli* (single cropping) land, gives however a good crop even when it is sown in November after maize. This variety has become so popular that it is confidently expected that it will occupy the greater part of the 280,000 acres of irrigated wheat in the province within a very few years.

Cawnpore 13 shatters far too easily and suffers much from the attacks of birds, and is also affected by rust more especially when the ears are lengthening and about to mature, and its straw is just a little too long.

Trials with the two new Punjab varieties (Pb. 8a, Pb. 8b) have shown that the former is a wheat of the very highest quality which may suit unirrigated land in the North-West Frontier Province.

In the Central Provinces several new wheat crosses were made and the existing crosses of F_2 generation were grown and tested for rust. Some varieties of wheat from Mesopotamia which are under trial in the Botanical Section have proved so far to be rust-free.

On the Tharsa farm, Pusa 12 and Sukerhai Pissi have, over a period of years, given the best results, and there are six seed farms for the propagation of these wheats. It has also been found that on light and rather inferior black soil known as *dorsa*

the outturn of wheat can, by irrigation, be increased by approximately 15 per cent., and that one irrigation answers better than two or more. Irrigation combined with manure (oilcake) greatly increases the yield.

In the Chhattisgarh Division Pusa 12, Pusa 100 and Mundi Pissi and Sukerhai Pissi are in demand, and there are 24 private seed farms to supply the seed of these varieties. In the Northern Circle, of the new varieties of wheat No. 90 has done well on light lands with irrigation, No. 88 is a favourite in the Jubbulpore *haveli*,* AO13 continues to give satisfaction in the Nerbudda Division, Pusa 4 which is an early variety and apparently rust-resistant has given good results in Mandla and AO68 and 49 promise very well in Seoni District. AO13, which is a selection from Sukerhai Pissi, is very susceptible to rust and is for that reason being replaced by AO88 and AO 89 in the Jubbulpore *haveli*. AO129, 130 and 131, which are selections from new crosses and have strong straw and nice plump grain, are very promising. There are 113 certified wheat seed farms in this Circle.

In Burma experiments with macaroni wheat at Padu and with bread wheat at Hopin were continued. At the former station the strains selected in previous years again gave the best results. The Shan States and the area north of a line drawn from Katha to Kindat appear to be adapted for bread wheat. The plains to the south of this line will probably only grow macaroni wheat which in normal times is unlikely to take the place of imported bread flour.

Rice. The great importance of this crop to India both from the point of view of internal consumption as a staple food and also as an article of export needs no special emphasis. The world's export trade of rice is practically under the control of three countries, India, Indo-China and Siam, the exports of rice from India amounting to 40 per cent. of the total exports of rice-exporting countries. Burma provides more than three-fourths of the exports of rice from India as a whole and also usually sends to other provinces of India more rice than those provinces export.

* A very fertile plain consisting of a tract of embanked wheat fields in this district.

The area under paddy fell from 80,080,000 acres in 1916-17 to 79,712,000 acres in the year under report, but the total outturn rose from 34,791,000 tons to 35,952,000 tons, or 3 per cent. more than in the previous year; the yield per acre being 37 lb. better than last year and 86 lb. above the last decennial average.

The work of the Agricultural Departments in connection with this crop consists not only in the evolution of strains of superior yielding power and the distribution of their seed with the object of replacing inferior varieties or mixtures grown by the cultivators, but also in bringing about changes in the methods of cultivation by effecting a reduction in the seed rate, the adoption of transplantation where broadcasting is the rule and economic transplanting where planting in bunches is in vogue, and demonstrating the profit to be derived from the application of organic and phosphatic manures where water supply is assured.

The crop is receiving most attention in Bengal, Madras, Burma and the Central Provinces. In the first named province, Mr. Hector, the Economic Botanist, is continuing his work on crossing and has recorded additional information regarding the inheritance of useful characters in this crop. His pure line selection "Indrasail" holds the field in Eastern Bengal and has in addition given excellent results in Bihar and Assam. Further afield the Director of Agriculture, Central Provinces, testifies to its high yield at the Raipur farm. It may, however, be mentioned that several new transplanted varieties have been selected which promise to be almost the equal of "Indrasail" in yield. One of these is a comparatively fine paddy and if approximately equal to "Indrasail" in yield should be a valuable selection. "Indrasail" though of medium quality is rather too coarse to be palatable to the upper classes.

Work has also been commenced on the long-stemmed deep-water paddies which are grown over large areas of the inundated tracts of Eastern Bengal.

Of the *aus* (early) paddies the "Kataktara" variety selected out of several pure lines is now out on district trials in both Eastern and Western Bengal.

"Nagra," a selection from a local variety passing under that name and grown in tracts where water is plentiful, has proved the best yielder (according to quality) in the block tests at Chinsura, and it is proposed to distribute seed in selected areas in Western Bengal.

In Bihar a small quantity of "Indrasail" paddy was distributed for experiment in the Bhagalpur, Patna and Chota Nagpur Circles where it definitely showed its superiority. The demand for seed this year was far in excess of the supply and over 29 tons were distributed.

Three varieties of deep-water paddy obtained from Bengal for trial in the large flooded area in the north of the Bhagalpur Circle have also given good yields.

A collection of different paddies in the province has been made with a view to grow them in pure cultures. This work is in progress at Bankipore, Cuttack, and Sabour farms. A survey of local paddies has also been begun by the Deputy Director of Agriculture, Chota Nagpur Circle.

In Assam experiments in the pure line breeding of rice were continued for the fourth year at Karimganj. As in last year these have been restricted to the early *aus* and *sail* varieties. No variety has however yet proved to be sufficiently outstanding to justify its recommendation for distribution.

In Madras the crop is receiving the attention of the Government Economic Botanist at the Paddy-breeding Station, Coimbatore. Two points which have now been definitely proved in the inheritance of characters in this crop are of special interest, *viz.*, a very definite connexion between a certain type of golden colouring and the shape and size of the grain and some connexion between another type of golden colouring and duration of the plant. The same two strains which in previous years headed the list repeated their performance this year and will now be tried on a field scale in the Coimbatore District. A large number of new strains obtained from crosses are coming on and will be tested for yield in their turn.

At Manganallur the selections from Red and White Samba were tested for yield against the farm bulk selections for which there is already a great demand. Certain of the selections

yielded from 15 to 24 per cent. higher than the farm seed and these have been selected for multiplication this year.

Spacing experiments carried out at Coimbatore since 1917 with two varieties of paddy have given some definite results. They show that in the case of the finer and longer growing variety Sinna Samba, the plots planted with single seedlings 6″ apart give the best yields of both grain and straw. In the case of the coarse and more rapidly growing paddy, Sadai Samba, however, the best yield of grain was given by seedlings planted in threes at 12″ apart, while the best yield of straw was given by the plot planted thickly in the local manner. The value of the several methods depends on the relative value of grain and straw. At present prices the crop obtained by the local method is somewhat more valuable than any of the plots planted with single seedlings, either 4″, 6″ or 9″ apart; but the plots planted with seedlings in two's at 9 inches or in three's at 9″ or 12″ gave more valuable crops than the local method. Single planting may thus result in some loss of straw in the shorter term varieties and for these somewhat thicker planting is advisable. But the experiments as a whole entirely justify the advice given by the department to ryots to plant their paddy very much more economically than they are accustomed to do. Not only can they save seed worth some Rs. 2 per acre and still get quite a good crop, but in most cases they can considerably increase the crop.

The results of the four years' trials at Samalkota to test the value of hot weather cultivation on the succeeding paddy crop have been uniformly in favour of the practice.

An important experiment was started at Coimbatore to test some of the problems raised by the work of Dr. Harrison on paddy soils. The experiment is designed to test separately the effect of the addition of organic matter and of nitrogen to paddy soils, and also to bring out any difference due to growing a green manure crop on the field to be manured as compared with bringing in the green manure from outside.

Paddy seems to respond well to a concentrated nitrogenous manure such as ammonium sulphate applied in addition to green manure. Dr. Harrison has shown that the nitrogen in the green

manure is largely dissipated in the form of gas, so that the plant does not make use of all the nitrogen contained in this manure, as was formerly thought to be the case.

In connection with the manuring of paddy soils with organic and phosphatic fertilizers we give the following extract from the Director's report:—

"The whole question of paddy manuring is becoming of great importance. We have shown that by economic planting, by green-manuring, and by using selected strains, it is possible to increase the yields of paddy very considerably. But there is a limit to this which has already been reached in many cases, the limiting factor being the quantity of available manurial constituents, especially phosphorus and nitrogen, in the soil. To obtain still better yields, more intense manuring is necessary. There is not enough cattle manure to go round so that the use of artificials is indicated. Our experiments have shown that the insoluble phosphatic manures, *e.g.*, bonemeal and mineral phosphates, are rapidly decomposed and made use of in paddy soils in the presence of organic matter. This enables us to recommend these comparatively cheap manures instead of the dearer soluble phosphates, *e.g.*, superphosphates, which depend for their manufacture on sulphuric acid which is scarce and expensive.

It is also obvious that in these days we ought to do all we can to increase the available supplies of food-grains, and that the best way to do this in Madras is by better manuring of paddy. We are therefore starting a large scale demonstration experiment in the Tanjore delta this year, giving out a manure mixture, based on our experience at Manganallur, for trial by ryots on a large number of plots.

There are large deposits of mineral phosphates, in the form of nodules, in the Trichinopoly District within a few miles of the Tanjore delta. Up to the present these nodules have been little used owing to the fact that they cannot profitably be converted into soluble superphosphates. But the experiments of the acting Government Agricultural Chemist and our field experiments at Manganallur are showing that this form of phosphate is readily used by the paddy plant. We therefore have a valuable supply of phosphate next door to the delta and the exploiting of this is obviously a matter which must be taken up seriously."

In the Central Provinces the testing of rices was continued and selected strains were sent from the Botanical Section to the

Adhartal (Jubbulpore) and Raipur farms for further trial. Seventeen new rices were obtained from the Federated Malay States and are being tried on the Nagpur and Raipur farms. The systematic study of the wild rices was continued. About 50 types have been isolated and an attempt is being made to study the character and nature of the natural crosses obtained. An enquiry into the origin of awns in cultivated rices has been taken in hand with a view to ascertaining whether the presence of awns is a variation or the result of natural crossing.

Over 12,000 acres of G. 19, a selected strain of *gurmatia*, a late variety, were grown in Chanda District. In Bhandara also this selected strain is being widely taken up. The chief varieties propagated for distribution in Chhattisgarh were *gurmatia, chinoor, luchai* and *parewa*. The department has now got a limited number of late, medium and early rices which have surpassed all others in yield or quality or both, and it is proposed to distribute only the most productive strains of the best varieties.

In the Northern Circle there is a big demand for the early varieties, *basmatia* (which gives a good yield of fine rice) and Nos. 16 and 17 (Mr. Graham's selections).

In the spacing experiment *gurmatia* seedlings planted singly 6 inches apart did better than two's, three's and bunches planted at the same distance. In the case of *parewa* which does not tiller so well, a higher seedling rate showed up better. The application of san-hemp as a green manure to the rice plots at the time of puddling them for transplantation gave a net profit of over Rs. 17 per acre.

In Burma selection work on this crop was continued at Hmawbi in the Southern Circle. A new type, Ngasein No. 10, yielded 3,500 lb. per acre on a field area of 17 acres, while unselected Ngasein gave only 2,200 lb. The variety is now under distribution. Ngasein 2104 continues to be popular in the districts of Kyaukse and Mandalay where it still gives good results in comparison with other varieties. The Deputy Director, Northern Circle, estimates that some 20,000 acres are probably under this variety. There is said to be a demand in this circle for the seed of quick ripening Japanese varieties

for sowing under conditions which demand short-lived paddies. The Philippine method of transplanting rice seedlings on plantain leaves on which a thin layer of mud is placed was tried in the Southern Circle. The method enables seedlings to be transplanted in 15 days after sowing and may be of use in flooded tracts where nurseries cannot be made.

Manurial trials at Mandalay have demonstrated the value of organic and phosphatic manures separately and in combination, the value of burnt paddy husk as a dressing for heavy soil and the fact that the use of bonemeal though it gives a considerable increase in the crop barely covers its cost. Those at Hmawbi indicate (1) that with practically all the manures used the effect is greater on the straw than on the grain yield, (2) the superior effect of bulky organic manures, (3) that superphosphate appears to give better results than bonemeal, (4) that on Lower Burma soils potash manure does not seem to be necessary, (5) that sodium nitrate instead of giving good results seems to inhibit the growth of rice plants, (6) that nitrolim cannot rank with sulphate of ammonia which alone or in combination with superphosphate and potassium sulphate is a powerful stimulant, and (7) that lime appears to have little effect.

In Travancore work in pure line selection and hybridization was continued on the Paddy Farm at Nagercoil.

Cotton. The total area under this crop rose from 21,745,000 acres in 1916-17 to 24,781,000 acres in the year under report, but the total yield was only 4,035,000 bales of 400 lb. each as against 4,489,000 bales in the previous year. This was due to the average yield per acre having been only 65 lb., on account of unfavourable weather conditions, as against 83 lb. in 1916-17, and 77 lb., the last decennial average.

The total value of raw cotton exported during the year amounted to over 43 crores of rupees and that of cotton manufactured to 13 crores. This combined value was the highest recorded, showing an increase of 13 per cent. over the previous year and of 25 per cent. over the pre war quinquennial average. The increase was almost entirely due to the high range of prices of raw cotton. For example, the wholesale price of Broach cotton per *candy* (of 784 lb.) at Bombay was Rs. 415 at the beginning of the year. It soared to the extraordinarily high

level of Rs. 698 in March. The average for the year was Rs. 507, as against Rs. 346 in 1916-17, and Rs. 303, the pre-war average.

In connection with all work on cotton it should be remembered that the cultivator appreciates the advantage of ginning percentage only to a small degree, and the market as a rule is very little sensitive to it unless special arrangements are made to have ginning tests taken. The cultivator has considerable and well justified doubts whether he will get any better price on account of improved staple. Even in the matter of increased yield of seed cotton, the full advantage of which the cultivator must get, cotton which ripens gradually over a considerable period of time does not afford such spectacular evidence of increased yield as is the case with other crops, and it is only careful cultivators who keep records who will quickly appreciate the advantage.

In **Bombay** the Agricultural Department has four kinds of cotton for the four distinct tracts, *viz.*, (1) Surat No. 1A for South Gujarat, (2) *Neglectum roseum* cotton for Khandesh and the adjoining Deccan districts, (3) Dharwar No. 1 for the Kumpta tract, and (4) Gadag No. 1 for the Dharwar-American tract. Surat No. 1A gives 50 lb. of seed cotton per acre more than ordinary Surat cotton. It has a superiority of 2 per cent. in ginning percentage (=6 per cent. more lint), and the lint is valued at Rs. 15 per *candy* more than Surat cotton. *Neglectum roseum* gives 100 lb. of seed cotton per acre more than the ordinary Khandesh mixture. It has a superiority of 3 per cent. for ginning percentage (=9 per cent. more lint). The lint fetches Rs. 20 per *candy* more than Khandesh cotton on account of its colour and bulk.

Dharwar No. 1 gives 50 lb. of seed cotton per acre more than Kumpta cotton. It has a superiority of 2 per cent. in ginning percentage (=8 per cent. more lint). The lint is valued at Rs. 30 per *candy* more than Kumpta cotton.

Gadag No. 1 gives 50 lb. of seed cotton more per acre than Dharwar-American cotton. It has a superiority of 4 per cent. in ginning percentage (=13 per cent. more lint). The lint is valued at Rs. 6 per *candy* more than Dharwar-American cotton.

Candy=784 lb.

The trade want a long and uniform staple and Dharwar No. 1 and Surat No. 1A have a staple markedly in advance of the local standard. It is however not on the ground of staple mainly that the department has selected them for distribution from the number of other promising cottons on the farms. Mr. Keatinge says:

"Indeed on the Surat and Dharwar farms we have other cottons which yield fairly well and are distinctly superior in staple to the ones we have selected for distribution. As a result of some years' experience in marketing seed cotton, it is clear that it is very difficult to obtain for seed cotton bearing a superior staple a constant and adequate premium representing the superiority. Seed cotton is difficult to value for staple, and the trade itself states that the spinning test is the only reliable one; and this, of course, cannot be made applicable to seed cotton. If this department can give a guarantee that a certain amount of cotton is superior in staple the buyers will pay a premium. This arrangement is possible on a small scale for cottons that we can adequately supervise, and in such cases premiums are obtained. But when we put out our cotton seed on a large scale, it is impossible for us to give a guarantee that no substitution, mixing or fraud will occur between the field and the spinning mill, with regard to cotton which is handled by hundreds of persons over whom we have no control; and this fact will, I think, be appreciated by persons acquainted with the circumstances of the trade. The policy therefore which we have adopted is to select for distribution seed of cotton which, in the first place, is best suited to the locality from the agricultural point of view (*i.e.*, which gives the largest outturn of seed cotton), and which, in the second place, has the best ginning percentage (*i.e.*, which gives the largest return of lint per unit of seed cotton). As regards staple, we make it a condition of selection, for distribution in the tracts which grow good stapled cotton, that the seed which we distribute must produce cotton with a staple at least as good as the local staple. In cases (1), (3) and (4) mentioned above, we have more than worked up to this condition as regards staple, while in case (2) of the *roseum* cotton in Khandesh, the tract is not one which produces a good staple, and *roseum*, though distinctly short in staple,

realizes a better price for its lint than the cotton of the local mixture, and therefore, presumably, suits the trade requirements. *Per contra* in the case of selected strains of Goghari cotton in the Broach District, the condition as to the staple has hitherto prevented us from distributing seed which gives an excellent yield; but the indications are that continued selection will bring the staple up to the required standard."

During the past year, 1,235 acres were sown with Surat No. 1A seed and the department made the usual arrangement for ginning the cotton and marketing the lint. Cotton worth Rs. 1,16,000 was marketed in this way, and apart from the profit which the cultivators made from the increased yield of seed cotton, the superior quality and higher ginning percentage brought an additional sum of Rs. 7,700, a net gain of 6½ per cent. of which 4·4 per cent. represented superior ginning percentage and 2·1 per cent. superior staple. A good deal of improved cotton seed was also distributed to other cultivators who made their own arrangements to dispose of the produce.

Dharwar No. 1 has a good future before it and there should be no great difficulty in spreading it through the Kumpta tract. During the past season it is estimated that the use of the department's cotton seed in this tract brought additional profits of 1½ lakhs to the cultivators. In the Southern Mahratta Country the department has also popularized Broach and Cambodia cottons in certain localities. These cottons do well only in restricted areas but within these areas the people are keen on them. They need detailed botanical work, and though the area affected is small this work is well worth doing when opportunity offers.

In **Madras** the selection, testing and multiplication of single plant selections of cotton was continued on the Agricultural Stations at Nandyal, Hagari and Koilpatti. As a result of experiments, the department has decided to put out in Kurnool District Nandyal No. 14 in place of Nandyal No. 2 as rapidly as it can be multiplied. It may be mentioned that Nandyal No. 14 has been very well reported on by the spinning mills. It gives a good yield of *kapas*,* but unfortunately the ginning percentage is low so that whether the ryot will take

* *Kapas* = unginned cotton.

kindly to it depends on what premium the firms are prepared to pay for its good qualities. It would also help greatly if local buying firms would set up gins at Nandyal to deal with this cotton so that the seed might be kept pure. At Hagari also, Nandyal No. 14 gave a very good yield, *viz.*, 90 lb. of lint per acre, as compared with an average of 50 lb. or less for local cotton. Of the 11 selections on this farm Hagari No. 1 at present distributed is not satisfactory in yield for the "Westerns" tract, *i.e.*, the Bellary District, and it will be replaced either by Hagari No. 25 or Bellary No. 5.

The results of the last two years' tests at Koilpatti show that Company No. 2 and 3 give 31 and 39 per cent. more lint per acre respectively than does the ordinary cotton from which they were selected.

We quote the following from the Director's report:—

"At a very conservative estimate 75 per cent. of the cotton crop from Satur southwards and 50 per cent. of the crop between Satur and Virudupatti is Company cotton. It is also grown in a number of places north of Virudupatti. This means that country cotton will practically disappear next year as there will be ample seed of Company cotton for everyone and this alone will be sown. We shall in fact reach the end of the first stage of our work in this tract, *i.e.*, the substitution of pure improved strains for the country cotton mixture.

"I should estimate that there were at least 250,000 acres of Company cotton in 1917-18. At a very conservative estimate an acre of Company cotton is worth Rs. 20 more than an acre of country cotton. It follows that the ryots of this tract are benefiting to the extent of 50 lakhs of rupees this season owing to the work of the Agricultural Department."

It was mentioned in last year's report that as the result of an energetic campaign carried on against the low grade cotton *pulichai*, it was practically stamped out in the 1916-17 season. As a precaution, however, the firms renewed their agreement for another year from October, 1917, and the department kept a look-out for *pulichai* among the ryots' crops. Practically none was found except stray plants which the ryots readily weeded out. A little *pulichai* still exists on the extreme east of

the cotton area where the department had not yet done much work until this year, but it may be said that this inferior cotton is now practically extinct in the Tinnevelly tract.

There was a very great extension in the cultivation of Cambodia cotton this year, the crop being estimated at over two lakhs of bales. Much of it was of poor quality due to its having been grown as a dry crop on unsuitable land and because it often stays on the land for two or even three years with the result that it becomes a prey to insect pests. Cambodia seed obtained from French Indo-China and from China showed at Coimbatore an extraordinary mixture of types, and the crop was on the whole much inferior to local crops. It will, however, provide useful material for future selection work.

A site for a special Cambodia farm has been selected and arrangements have been made for seed supply and the establishment of seed farms. The strains so far selected at Koilpatti and Coimbatore will be used as the basis for further selection work in the future.

The Cambodia-Spence crosses were a failure on black soils both at Koilpatti and at Nandyal. They are being tried again on red soils at Coimbatore.

In **Berar** where the department has done such substantial work in replacing the prevalent mixture by the prolific short staple *roseum* cotton which is so profitable to the cultivators, excessive rainfall resulted in a reduction of the year's crop from the 786,591 bales of 1915-16 to 301,899 bales. *Buri*, as was to be expected in such a wet year, did comparatively better than *desi* varieties. There are over 555 seed farms for the production of *roseum* seed and 50 for *buri* cotton in Berar from which the magnitude of the work going on can be easily realized.

In the **Central Provinces** some landholders in Chhattisgarh were induced last year to grow long staple cotton on *bhata* soil in their villages for demonstration. The value of the yields obtained ranged from Rs. 80 to over Rs. 300 per acre, and an extension of the crop may be looked for in these soils as well as in the black soil rice tract where good drainage can be provided for. The department has also introduced *buri* and *roseum* cotton in the Kawardha State.

Cotton followed by groundnut promises to be a good rotation in places where the second crop can be protected from pig. The need of some such rotation is urgent in parts of the tract where the tendency is to grow cotton year after year on the best land with the result that it is now badly infected in many villages by wilt. The results of trials show that selection by the specific gravity method of heavy cotton seed for sowing does not lead to an increase in yield.

As regards botanical work, an early variety of cotton with a high ginning percentage has been isolated, and will, it is hoped, be found suitable for the plateau districts where ordinary *jari* is sometimes damaged by frost. Selection of American cotton obtained from the United Provinces and the Punjab has been taken in hand with a view to get a strain suitable for cultivation on the irrigable *bhata* lands of Chhattisgarh.

In the **United Provinces** the season was most unfavourable for cotton and it was impossible to make any test of Mr. Leake's hybrids, but sufficient seed has been preserved for a more extended trial under normal weather conditions. There are, however, indications that K. 22 is more intolerant of water-logging than ordinary *desi*. Several new selections are in process of purification and are likely to yield economically valuable races. A re-selected K. 22 showed considerable promise on the Cawnpore farm and is being grown on a large scale this year at Kalianpur and is also being tested on other farms.

The isolation of pure races from Cawnpore-American cotton begun by Mr. Burt in 1912 has now been completed. Several varieties that are highly reported on by the trade have been obtained pure and have also yielded well even in unfavourable seasons. The most promising in point of staple and habit are being distributed. Of these Ca 9 seems likely to become most generally popular. The spread of this type of cotton is dependent, firstly, on the maintenance of high price as compared with *desi*, and, secondly, an assured supply of water from the canals at sowing time. The latter was secured this year by special arrangements with the Irrigation Department; but any disturbance in the ratio of prices between coarse and fine

cottons, due to partial failure of the former crop, will predispose the cultivator to grow the *desi* cotton which gives less trouble and sets free the land more quickly for a *rabi* (winter) crop.

The cottons grown in the United Provinces passing under the name of *Gossypium neglectum* consist of a mixture of races, and a great deal of work has been done with a view to selecting types possessing definite points of superiority over those ordinarily grown. It was in this way that Aligarh White-flowered was isolated; in point of yield and ginning percentage it stands ahead of any other *desi* type. A new type has been isolated by Mr. Burt, known as Jn. 1, which has been pronounced equal in staple to best *kalpi*, a class which has hitherto commanded the highest prices among United Provinces cottons. It was tried at Madhogarh last year and did well there in spite of a bad season and has been distributed on a small scale this year in the Jalaun District, whilst a large area is being grown at the Cawnpore seed farm to provide seed for more extended operations next year.

As regards agricultural work, the season of 1917 was one of the worst on record for cotton. The American cotton, however, yielded rather better than *desi* and also commanded better prices. With a view to secure full prices for the growers and at the same time to maintain purity of the seed, the whole crop was purchased by the department and after ginning and baling sold on the open market. The prices secured enabled a total premium of Rs. 4 per maund of *kapas* to be paid to growers. These high profits led to a good demand for seed in the current year. But on account of shortage of seed and difficulties in its despatch by rail it has been mainly confined to villages within reach of the Cawnpore farm. The success of the American cotton in the Punjab has created a demand for this type of cotton in the western districts of the province and 10,906 lb. seed of Cawnpore-American cotton was distributed.

As is well known, the variety of American cotton successfully introduced in the canal colonies of the **Punjab** is No. 4F, and it now forms between 70 and 80 per cent. of the total American

1 *maund* = 82 lbs.

crop. The claims made for this type since its issue in 1913 are that it is hardy, rough-leaved and has a medium staple of full $\frac{7}{8}$ inch or what would be classed commercially as 1″. The area under American cotton rose from 215,000 acres in 1917 to 390,000 acres in 1918. It is estimated that 80 per cent. of the crop is pure 4F. At a very moderate valuation the extra gain to Punjab cultivators of this cotton in the present year is at least 60 lakhs of rupees. Among *desi* cottons Mollisoni No. 24 has consistently proved a heavy yielder in ordinary years. Some seed has therefore been given out this year to zamindars for trial.

Work on the evolution of better varieties goes on. It is possible that a better type than 4F will be forthcoming. In the course of a few years it will certainly improve as selection is carried through. Already there are other selections such as 275F, 280F and Risala American; the latter two are superior in staple to 4F but their yield is less. For the present therefore 4F holds the field. The department will go on issuing seed true to type so that the improved strain may not deteriorate. and owing to the existence of a large number of large estates in the colonies there wll be no difficulty in keeping seed pure.

It may be mentioned that irregular lint can be got from pure-bred seeds by certain influences of soil, irrigation and cultivation. The department is investigating these problems and improvements in cultivation such as sowing in lines and interculturing are being popularized.

Sugarcane. The area under this crop rose from 2,416,000 acres in 1916-17 to 2,796,000 acres in the year under report, which is an increase of 16 per cent., and the estimated total yield from 2,730,000 tons to 3,266,000 tons, an increase of 20 per cent. The average yield per acre during the year was 2,617 lb. against 2,531 lb. of last year and the decennial average of 2,219 lb.; the increase in yield being due to the fact that the monsoon was very heavy.

With the exception of cotton manufactures sugar is India's largest import: the quantity (excluding confectionery and molasses) imported during the year was 470,700 tons against 803,000 tons in 1913-14, but this on account of higher prices was

valued at 15 crores and 4 lakhs of rupees against 14 crores in 1913-14. As in the previous year there were no imports of beet sugar. It may be mentioned that the imports of beet have never bulked large in comparison with cane sugar imports. Among the exporting countries Java stands first and the Straits Settlements and Mauritius come next. But it must be borne in mind that the imports from the Straits Settlements are simply Java sugar transhipped at Singapore. The imports of Java sugar (424,000 tons) showed an increase of 8 per cent. over those of 1916-17 (392,500 tons) though the quantity still remains far below that (585,000 tons) imported in 1913-14, and will not increase until shipping becomes available again. The importation of Mauritius sugar was only one-fourth of the pre-war normal. This sugar is imported chiefly into the ports on the wesern side of India.

There are 39 sugar factories in this country. From the returns submitted by 30 (13 in Bihar, 9 in the United Provinces, 5 in Madras and 3 in Bengal and Punjab) to the Department of Statistics, it appears that they turn out, per day of 22 hours, 175 tons of sugar from cane (first sugars), 75 tons from cane (second sugars), and 258 tons from raw sugars. The maximum amount of sugar that can be produced by these factories is 533 tons per day.

The subject of the Indian sugarcane industry was considered at the last meeting of the Board of Agriculture held at Poona and it was felt that the industry is in need of immediate attention. That this is fully realized by Government was obvious from the remarks of Sir Claude Hill in his opening address at that meeting. As Government cannot be expected to take up the question of developing the industry in a serious manner until they have definite information on the subject, the Board passed a resolution particularly emphasizing the importance of starting without delay a bureau of information on the sugar industry. Such an institution is required for collecting in one office the scattered information recorded regarding the character of the sugarcane tracts in India, the varieties grown, the methods of cultivation and of making the finished product, the causes of success or failure in the case of existing or past concerns and

GROWTH OF JAVA CANES AT PUSA.

Note.—These canes were supplied by Dr. Barber for trial.

generally to give up-to-date, reliable information on the subject. This resolution is receiving the attention of Government.

As noted in previous reports the most important work on this crop from the botanical point of view is that of Dr. Barber at the Cane-breeding Station, Coimbatore. The work continued on the same lines as previously. The season was a good one for arrowing and 421 different cane varieties were in flower as against 96 last year. From these 77,000 seedlings were raised, the number being less than last year's 99,000 owing to the rejection of the large group of Saretha seedlings which have been proved useless. In fact this year marks the beginning of concentration on smaller numbers, sufficient experience having been gained to admit of this. The number of canes selected from the previous year's crosses as being probably suited to Northern India was 150. Nearly 5,000 seedlings were grown to maturity and analysed for their sugar content. Considerable knowledge has been acquired of the usefulness of different varieties and seedlings as parents and a " parents' register " has been opened in which every detail obtainable concerning the different varieties used as such is entered. As the result of experience the method of selecting seedlings for further trial has been improved, and in particular it has been found possible to estimate their sugar content before they are fully mature (which enables Dr. Barber to save a year in testing each seedling, as they can now be brought into line with the local seasonal cane planting a year earlier). It has also been decided that the period of preliminary testing at Coimbatore can be shortened, and as a result a beginning has been made this year in sending out some canes for definite trials in other parts of India—13 thick and 16 thin varieties having been sent to 16 different stations. The methods of analysis have also been simplified and standardized so that whereas in 1914 it took four months to analyse 2,967 seedlings, in the year under report over 4,500 seedlings were analysed in two and a half months. Investigation into the growth of cane both above and below ground and into methods of testing arrows for fertility was continued and papers on these subjects were read at the Indian Science Congress. A memoir on the classification of Indian canes has been issued by

Dr. Barber and a paper on the sugarcanes grown at the Coimbatore Station has been published in the *Agricultural Journal of India.*

We may now pass in rapid review the agricultural work done on this crop in the various provinces.

In **Madras,** J. 247 has been selected for distribution in the Godavari delta on account of its freedom from disease combined with a high yield of 5 tons of *jaggery* per acre. In South Canara the area under cane has risen steadily for the last 8 years and now amounts to 2,858 acres. Over 90 per cent. of this area is under the Red Mauritius cane introduced by the department.

There has been a considerable extension of the area under cane in the South Arcot District, following on the setting up, by Messrs. Parry & Co., of two out-stations for making *jaggery* for future refinement at their central factory at Nellikuppam. These installations consist each of 3 three-roller mills worked by steam plant, the waste steam being used for evaporating the juice; each installation can deal with some 700 acres of cane in a season.

The cane-crushing and *jaggery*-making plant at Singanallur near Coimbatore worked during the year for 153 days and for 11·2 hours per working day on the average. One thousand four hundred and thirty tons of cane were crushed and 135 tons of *jaggery* were manufactured. The percentage of juice obtained was 65, while the ratio of *jaggery* to cane worked out at 12·2 per cent. The actual cost of running the plant—fuel, labour and contingencies—worked out at Rs. 15-2-2 per ton of *jaggery*. The second installation near Hospet in Bellary District could not be worked during the year, mainly because repairs were not completed in time for the crushing season.

In **Mysore,** comparative tests for yield were made on the Hebbal farm with eleven seedlings from Red Mauritius and five from White Mauritius. Three of the former and one of the latter have given bigger yields than the Red Mauritius; they are vigorous and contain a high percentage of sucrose (over 20 per cent.) and only traces of glucose. Three thousand seedlings have been raised this year and planted for selection. A large

number of seedlings are being tested for their ratooning qualities and some of them are very promising.

Of the newly introduced canes, Striped Tanna, Tanna Blanche, J. 247 and J. 33A are very promising. J. 33A is very vigorous and yields heavily. It is therefore being multiplied for distribution. In the meantime Red Mauritius which has shown its superiority as a heavy yielder consistently for the past five years is being pushed until a still better variety is available. The application of oilcake as manure has proved very profitable. Spacing experiments have shown the advantage of planting cane in rows 3 feet apart. The three main recommendations of the department are—(1) grow Red Mauritius cane in place of the varieties planted at present: this will give an increase of from 10 to 25 per cent. per acre in yield; (2) use oilcake at the rate of at least 100 lb. of nitrogen per acre: double this amount will greatly increase the profits; (3) do not plant cane in rows closer than 2 feet apart: if an adequate quantity of manure is used, rows three feet apart would be even better.

Small power plants to crush canes for *gur*-making have been installed by sugarcane growers cultivating large areas; others have been installed at State expense in places where the concentration of cane growing justified the experiment; and more recently several have been established by co-operative societies which have been largely financed by State loans. The plant at Hudi near Bangalore worked successfully during the year. This was due to the fact that a regular supply of cane to the mill for the whole period was guaranteed; what is most essential in the successful working of these plants is good organization.

As regards the other cane-crushing and *jaggery*-making plants, difficulties in the regular supply of cane and in some cases bad selection of sites combined to make their working unsuccessful. The Director of Industries, Mysore State, hopes, however, to demonstrate that these factories are as paying concerns as rice mills, oil mills, flour mills, etc., and that they could be installed in areas where 100 acres of cane are planted every year.

In **Travancore** extension of the area under cane, the introduction of Red Mauritius canes, demonstration of the Poona

method of *jaggery*-making and the popularization of manures form the principal items in the department's work on this crop. Red Mauritius variety has been found to be the best and a large number of sets have been distributed to ryots. Manurial trials with ratoon canes have given as good results as with plant canes, namely, 7,700 lb. of *jaggery* per acre, the manure used being a mixture of oilcake, prawn skin and ashes. A private company has taken up 1,000 acres of virgin forest lands for sugarcane cultivation and a good portion of this area will be brought under the crop during the current year.

In **Bombay** excellent work on this crop is being done on the Manjri farm; much progress has been made in the trial of new varieties of cane, in cultural and manurial methods and in *gur*-making. The results obtained on the Manjri farm during the past 3 years have been written up and are now being published in the form of a Bulletin. There has been a substantial increase in cane growing during the past few years and a large number of cane growers are amongst the best of the cultivators. They have largely appreciated and taken up the methods advocated by the department. These are: green-manuring with *sann* (*Crotalaria juncea*); the application of nitrogenous top dressings; the planting of tops only; cultivation in straight lines which greatly reduces the consumption of water, keeps the soil open and reduces the cost of tillage; and the employment of economical furnaces and improved methods of *gur*-making. It is common now to find cane growers even in the remote parts of the Presidency trying the department's new varieties of cane and adopting its methods of cultivation. A sugar factory will soon be opened on the Pravara canal.

In the **Central Provinces,** Khari, Sunnabille and J. 247 sugarcanes have done well in Chanda District and are much in demand. Cane growers are now using oilcake for the first time as manure. The Poona furnace is being used in almost every village in the district where any considerable quantity of cane is grown. By the introduction of this improved furnace the cost of *gur*-making has been greatly reduced. A small power cane-crusher has been set up on the Tharsa farm with a

view to encourage cane growers in the neighbourhood who are at present unable to handle their crop with their existing bullock power.

Sugarcane is now being tried for the first time on the *bhata* soil and remarkably heavy yields are being obtained. The varieties introduced by the department up to date in the Chhattisgarh Division are Ashy Mauritius, Sunnbille and J. 247. Manuring cane with oilcake has now become a well recognized practice in the Division.

In the Northern Circle, Khari gives a profit of about Rs. 50 an acre more than the inferior local variety. *Karanji** cake which used to be considered of no manurial value is now being purchased by cane growers. The Nahan cane mills supplied by the department have also added largely to the profits of the cane growers. All things considered, it is reasonably certain that the area under cane and the acreage profits derived from its cultivation will be increased to a considerable extent within the next few years.

In **Bengal,** the examination and selection of local canes was continued and a selection of 10 has been made on the basis of analytical results and of personal experience of the respective canes in the field. The selected canes will again be compared amongst themselves with a view to final selection of one or two varieties. Of the local canes, Gandari from Dacca, Vendamukhi from Rajshahi, Samsara from Burdwan and Marikul from Mymensingh appeared to be the best. The three first are well known but Marikul which is a thinnish dark red cane of vigorous growth and high sucrose content does not seem to have met with any previous wide recognition. Of the exotic canes, Yellow Tanna and J. 247, the latter supplied by Dr. Barber, seem to withstand the conditions at Dacca best as drought-resisting varieties and are also very heavy yielders but their juice is only of moderate purity; therefore while excellent as far as *gur*-making is concerned they might be at a disadvantage as compared with some other canes when white sugar is the object. We quote the following from Mr. Finlow's progress report:

* *Pongamia glabra.*

"The conclusion to be drawn from the experiments recorded above are, that at three out of four experiment stations in Bengal, an exotic race generally leads the way in the matter of yield as compared with local varieties.

"On the other hand, at Dacca, Chinsura, and Rangpur there are local canes, namely, Gandari, Samsara and Vendamukhi, respectively, which, if not equal to the best exotics, are still capable of profitable cultivation.

"It would appear that, in most cases, exotic canes are not capable of retaining their good qualities indefinitely; but as far as Bengal is concerned, Yellow Tanna seems to be an exception. It has been grown in the province for many years now, and while still, on the average, one of the best, if not actually the best, *gur*-making canes, it is also probably the most robust variety. Noel Deer states (*Cane Sugar*, p. 29) that 'generally speaking they (Tanna varieties) are deep rooters and suffer only to a limited extent from the effects of drought.' This might have been written from experience with Yellow Tanna on the red soils at Dacca."

A site for the sugarcane station in North **Bihar** has been definitely selected and a complete scheme has been submitted to Government. Pending the opening of this station, a number of selected and exotic sugarcanes are being grown at the Sipaya farm. During the year the Government Sugarcane Expert, Coimbatore, sent to the farm 17 seedlings selected for Bihar besides 8 other varieties and seedlings of possible use. These are promising well. At Sabour the botanical work on the crop has resulted in a number of varieties being selected as suitable for the province and field trials are being carried out this season. In the Bhagalpur District, north of the river Ganges, the cultivation of the crop has considerably increased as a result of the establishment of the sugar factory at Lohat. Here a number of trials are being carried out with a view to introduce a heavier yielding variety; the results so far obtained are satisfactory.

In the **United Provinces** an unusually large area of medium sized canes, mainly J. 33, Mauritius canes and Uba, was sown. On the whole they did well; but considerable difficulty was

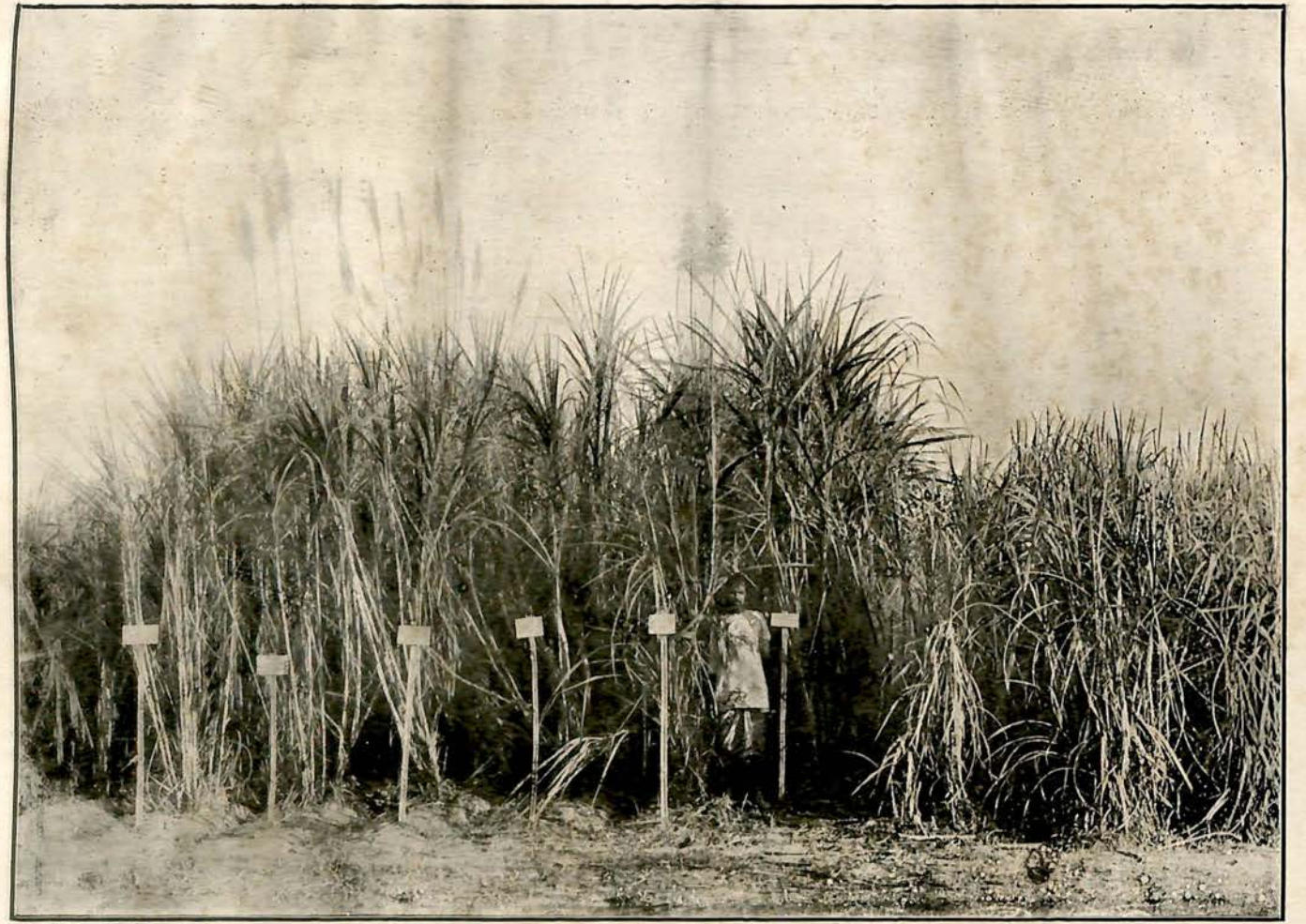


PLATE III.

DR. BARBER'S THIN CANES Nos. Co. 201—07.

KUSWAR
(North Indian thin cane).

The photo gives a good comparative view of the growth of these canes at Pusa.

experienced in disposing of the much heavier crops raised with the existing crushing appliances. Judging from the keenness of the demand, these canes have come to stay and it is mainly a question of selecting types best suited for the varying conditions of the provinces.

At the Shahjahanpur Research Station a number of new canes have been tried; some of these are likely to give better results than those that have been grown for some time in the provinces. The latter, in some instances, have developed a tendency to smut, and it is possible that the strains will have to be periodically renewed. Selected canes likely to prove suitable for Upper India have been received from Dr. Barber, but it will be some years before they can be multiplied sufficiently for trial on a field scale. The main efforts of the department, however, are directed not so much towards introducing better canes as to improving the general standard of cultivation. It has been repeatedly shown that the outturn of cane per acre is unduly low and in the areas feeding the Nawabganj cane factory it rarely exceeds from 8 to 10 tons per acre. It would be well, if the ordinary cultivator were to confine himself to the canes to which he is accustomed and endeavour to improve production by better tillage and manuring. Nothing but disappointment is likely to result from allowing smaller men to experiment with better and richer canes on wholly imperfectly tilled and manured land. On the private farms of zamindars and in the fields of larger tenants these superior canes have generally done well and amply repaid the additional cost of cultivation.

The cultivation of medium sized cane has given prominence to the striking deficiencies in existing methods of crushing and boiling. On many of the private farms, or on zamindars' fields, yields between 20 to 25 tons of cane per acre were obtained, and, where any but a small area was sown, it was beyond the capacity of the small bullock mill to deal with the produce. Mr. Sharma, Deputy Director, Eastern Circle, quotes a case in which out of 15 acres of such cane not more than a quarter could be disposed of, while an attempt to get rid of the balance as chewing cane flooded the market. Assuming that intensive cultivation is found profitable, the introduction of power crushing and

improved boiling processes is likely to spread as soon as the plant is procurable. Last season, the department let out the whole of its crushing plant available and received many applications which it was impossible to comply with. Though crushing with small power plant may not be economically sound, it is probably an intermediate stage through which the provinces have to pass before the opening of factories equipped with modern crushing plant. The employment of mechanical power will, however, certainly be hastened by the spread of improved cultivation owing to the sheer impossibility of disposing of the produce by bullock power.

With a large supply of cane the Nawabganj factory was kept running for the greater part of the season. In all, some 1,098 tons of cane were dealt with and the sugar disposed of at profitable rates. A separate account of the working of the factory has been published by Mr. Hulme, Sugar Engineer, as *Pusa Bulletin* No. 82. The factory attracted rather more notice this season and was visited by a certain number of persons interested in the industry.

In the **Punjab,** Mr. Wilsdon conducted the agricultural survey of sugarcane in the Rohtak District on the lines followed in Karnal District during the previous two years. The object of the survey was to find out some suitable place for the opening of a Government sugarcane farm and to investigate the possibilities for the installation of a sugarcane factory in the Southern Punjab. The results of the survey indicate that some such place as Samalkha or Soneput will be best suited for the Government cane factory when conditions allow of its being started. The yield and quality of the canes grown in this district are much better than those of the Northern Punjab. Moreover the cane here is not subjected to the effect of frost as in the Gurdaspur District and other sub-montane tracts. Some 30,000 acres are grown in the two *tahsils* of Soneput and Paniput. The land is good and canal water is available almost in every village of the *tahsils* lying on the south-west of the East Indian Railway line. In addition to these advantages there are easy means of transportation. Besides the East Indian

Railway, the Grand Trunk Road and the Western Jumna Canal, which is navigable, are easily accessible.

In the **North-West Frontier Province,** after a long series of trials it is believed that the methods of growing cane and making *gur* on a small scale that are practised by the Peshawar cultivators are as efficient and cheap as any that have come to the notice of the department. The local Pounda cane has also held its own in yield and freedom from disease, though not in early maturity, against several imported varieties. In the hope that white sugar may be made at Peshawar before very long, it is proposed to test the suitability of a motor tractor in preparing the land and cultivating a large block of cane at Tarnab. Tests continued to be made as to the preservation of sugarcane in clamps and windrows. It costs only Rs. 4-8 to Rs. 5 to produce a ton of thick cane on the banks of the Kabul river. D. 74, the early ripening cane that in recent years has almost displaced other varieties in the plantations of Louisiana, has been found successful at Tarnab. It is probable that this cane will extend the crushing season at Peshawar, and it may prove to be the variety that will establish sugar factories in this tract. Sugarcane and sugarbeet follow each other admirably in rotation and this offers an enormous advantage to a sugar concern which might lease land to insure a regular supply of raw material. Land may be devoted exclusively to the production of sugarcane, sugar-beet and clover.

In **Assam,** the testing of varieties, manurial experiments in the cane rotation and trials of different planting methods were continued at Jorhat and over a lakh of superior sets were distributed. Among the ratoons, Striped Mauritius and B. 376 continue to do well. Of the two new varieties, B. 6450 gave a better crop than Barbados A with a much higher sucrose content and purer juice, and compared very favourably with Striped Mauritius and B. 376 which have consistently done well for years. The average yield for all varieties taken together was 33·4 tons per acre. Barbados A gave 43 tons per acre. These results show what can be done with cultivation, manuring and a proper rotation on a very bad soil though cane is grown two years out of four on the same land. The highest yield of suc-

rose per acre in expressed juice was returned by Striped Mauritius with 3·5 tons, followed by B. 6450 with 3·37 tons.

During the year the Kamrup farm entered on the fourth year of the experiment proper and there were 503 acres under cane. The varieties under cultivation were Striped Mauritius and Barbados 147 and 376. Mr. Maxwell, the cane contractor, converted his *gur* factory into a sugar factory, but there was very great delay in erection and no cane was milled before the end of February. Analyses made showed that the ratoon crop was ready for milling early in December. Various defects in the running of the machinery together with the late start practically made the last season one of testing machinery. With a view to bringing to a decisive issue the experiment on sugarcane cultivation by steam tackle and on a factory scale, it has been decided to retain the farm and renew the cane contract for a further period of five years from March 1919.

In **Burma** trials of Dr. Barber's canes are being made. Several of the introduced varieties have done well both at Singaing (Kyaukse District) and at Hopin. There is reason to believe that the Namyin Valley is suitable for cane. Cultivation is expanding fast in the Pyinmana Sub-division. It has been pushed in Prome and Tharrawaddy districts and a power crusher has been set up near Paungde in Prome. In the Toungoo District an enterprising gentleman has a cane plantation of over 200 acres and has put down a factory in which this year he will attempt white sugar. Cane is doing well at Tatkon and it is interesting to note that there is a large area between Pyu and Tatkon suitable for this crop. The impediments to cane cultivation are (1) the cost of the seed —about Rs. 40 per acre—which deters many cultivators, and (2) the cost of a *jaggery*-making outfit. These are receiving the attention of the department.

Jute. The area under jute in India rose during the year under report from 2,703,000 acres to 2,730,000 acres and the estimated total yield from 8,306,000 bales of 400 lb. to 8,840,000 bales. The total outturn exceeded that of 1916-17 by 534,000 bales, or 6 per cent., and the yield per acre was 66 lb. more than last year. The value of raw and manufactured jute exported out of India amounted to 49 crores and 29 lakhs of

rupees, a decrease of 15 per cent. as compared with the previous year, but an increase of 16 per cent. over the pre-war average. The decrease was entirely in the exports of raw jute.

At present the crop is confined to Bengal, Assam and part of Bihar. Mr. R. S. Finlow, Fibre Expert to the Government of Bengal, has now got one type each of the *capsularis* and *olitorius* jute for distribution in the districts. These are Kakya Bombai and R. 26. Trials of Kakya Bombai jute by firms at their mofussil agencies have shown an all-over average increase of 164 lb. in favour of this variety. As all classes of lands were included and the experimental error was further reduced by the reversing of the plots, this increase of 164 lb. taken with the last year's average increase of 247 lb. per acre gives an average for the two years of 205 lb. of fibre in favour of Kakya Bombai jute over local varieties. As Mr. Finlow's original claim was that his selection was about 123 lb. per acre on an average better than the average of local varieties, the results show that his estimates have been well within the mark. Mr. Finlow mentions another point which is of interest to those who have followed the history of development of late varieties of jute. He has contended all along that, if yield is to be the main object in selection work on this crop, the late flowering (not necessarily the slow growing) races will alone give maximum yields owing to the natural branching of the plant at the time of flowering. For some years a controversy raged around this point, it being contended that in districts where paddy was grown immediately after jute, the latter if late flowering would not be ready to cut at transplanting time. The fact of the matter is that jute cut before flowering is of better quality than when cut later, and that, within limits, the crop can be cut practically at any time. The worst class of jute from the point of yield and quality is the early flowering variety, and the substitution of a late flowering race in Northern Bengal for some of the early races would undoubtedly be of great economic importance.

Mr. Finlow by no means believes that Kakya Bombai is the last word in jute selection. A large number of single plant

Kakya bombai is a late maturing variety.

cultures are grown at Dacca with a view, if possible, to find a better race than this one. Some artificially produced hybrids are also under observation.

Over 878 cwt. of Kakya Bombai seed were distributed during the year.

The results of trials of the best pure lines of *C. olitorius* have shown R. 26 and two others to be better than the rest. As R. 26 is considered rather more desirable all round it has been selected for outside trials. Comparative outturn trials with these three best varieties will however be continued. During the year 8½ cwt. seed of R. 26 was distributed and arrangements have been made to supply 146½ cwt. next year.

It may be mentioned that a fungoid disease (black band) has recently been found to do much damage to the seed crop of the Kakya Bombai variety in Bihar. The parasite remains in the soil between successive crops and is also carried on the seed to some extent. Reference to this disease will be found in the section of Mycology and Plant Pathology below (see page 81).

A large amount of chlorosis made its appearance amongst the *capsularis* varieties at Dacca. The single plant cultures behaved in a singular manner with regard to the disease, nearly all containing chlorotic and non-chlorotic plants in varying proportions, only two pure lines showing complete immunity. The *olitorius* varieties on the other hand were singularly free from the disease. An examination of the rooting systems of diseased and healthy plants showed that in general chlorotic plants were deeper rooted than non-chlorotic. Mr. Finlow is inclined to think that the disease may thus be more or less confined to the red soils which have poisonous sub-soil strata, but a great deal of it was noticed by Mr. Milligan at Rangpur this year in the young crops on the silt lands of that district. There is therefore a possibility that this disease may yet become formidable in some districts. If however hereditary immunity can be obtained by cultivating shallow rooted varieties, the cure is probably already in the hands of the department.

Manurial trials on the red soils have again shown marked differences in yield due to the application of potash whether in the shape of water hyacinth ash or as potash salts. The use

of this manure as an antidote to *Rhizoctonia* has also been very effective.

In Bihar a demand for the Finlow variety of jute has sprung up on account of its high yielding qualities and 73 cwt. of seed were supplied by the Bengal Department for distribution. In those areas where seed has already been distributed the cultivators are reserving a certain area of their crops for the next season's seed. The most successful outturn of jute was obtained at Sarsi in Purnea District where 861 lb. fibre was obtained from a quarter of an acre. At two centres a trial was made between the Kakya jute seed obtained from a crop grown in the previous season in Purnea and that imported this season. In both cases the former gave a very much heavier yield.

In Assam Mr. Finlow's variety gave the highest yield at Karimganj and its superiority was demonstrated with good results in Sylhet and Kamrup. Arrangements have been made by the Bengal Department to supply 18 cwt of Kakya Bombai seed annually to Assam. In order to meet the local demand for seed, cultivators are also asked to return seed equivalent to the quantity given out to them. The department has since arranged with Messrs. Birkmyre Brothers to be supplied with a large quantity of seed from their plantation at Kumarikhata in Kamrup next year.

Trials with jute were made at several agricultural farms and other places including several jail gardens in Lower Burma. Results indicate that *C. capsularis* does better than *C. olitorius*, that in Lower Burma jute must be sown at latest after the first heavy shower in May, that the soil should be a good loam with a "body" of silt and plenty of drainage and that the sandy lower soils of Burma are unsuitable. Trials on the rich loams of the inundated tracts of the Sittang river appear to be promising. In the Northern Circle jute was successfully grown at Hopin, *C. capsularis* producing at the rate of 1810 lb. per acre. The quality of the fibre was declared by experts to be "superior" and was valued as high as Rs. 9 per maund of 82 lb. in Calcutta. An attempt is being made to grow a trial consignment of 10 to 20 tons this year and seed has been distributed. Wild jute grows luxuriantly on the better drained

land near the Namyin river two miles from the Hopin farm and the crop would doubtless thrive there. The area of such land in the valley is great, about 50 miles in length by a quarter to half mile wide. The results of further trials will be awaited with interest.

Indigo. With the demand for dyestuffs which became universal when the supplies of synthetic dyes from Germany were cut off by the war, those natural dyes which were still obtainable found a ready market. The most important of these was of course indigo. The value of annual exports of this dye from India which was reduced to £142,000 only just before the war, rose to £600,000 in 1914-15 and to £1,386,000 in the succeeding year. The demand from England alone increased from 3,400 cwt., the pre-war average, to 30,600 cwt. (value £967,000) in 1915-16. This gave a great impetus to indigo cultivation, and the area under this crop rose from 148,400 acres in 1914-15 to 770,000 acres in 1916-17. But with the development of the synthetic industry in the United Kingdom and the restrictions on shipping, both the quantity of exports and the average declared value per hundredweight fell in 1916-17 and went still further down in 1917-18. This naturally reacted upon the area under this crop, which was reduced from 770,000 acres in 1916-17 to 691,000 acres during the year under report, and the forecast for 1918-19 available at the time of writing shows a further reduction to 300,700 acres. It may however be mentioned that the falling off has been especially in Madras and the United Provinces where the temporary spurt was the highest and where the industry is mainly in the hands of small holders who are not in a position to brave the vicissitudes of the market. On the other hand, in Bihar where only a really well organized industry exists and where a superior grade of indigo which can compete in the international market is manufactured under European supervision, the area rose from 76,500 acres in 1916-17 to 85,900 in 1917-18.

Now with the cessation of hostilities and the consequent easing of the situation as regards transport facilities natural indigo will have to compete with the synthetic dye produced abroad, and the problem before the Indian industry is how to

put on the market the natural stuff in the most acceptable form and at the cheapest price possible. That the aid that research can give during the next few years will decide the future of the industry is being universally recognized, and the Government has imposed with the consent of these interested a cess on indigo exported from India to provide funds for the promotion of research in the interests of the industry. The last two years' work of the Indigo Research Chemist at Pusa has shown that great improvements can be made and if steps are taken to adopt at once such improvements as are clearly possible the future of natural indigo is by no means a hopeless one. The fate of natural indigo will be determined by several factors, each of which has its own special importance :— (*a*) improvements by botanical selection, (*b*) improvements in agriculture, (*c*) chemical or bacteriological improvements in actual manufacture, and (*d*) improvements in methods of marketing.

The two species of indigo cultivated in Bihar are *Indigofera Sumatrana*, or the Sumatrana plant, and *Indigofera arecta*, or the Java plant. Of these the Java species not only yields, as a rule, far more green plant per acre, but far more dye per 100 maunds of plant than the other variety. Unfortunately, however, serious difficulties have been encountered during the last few years in extending the cultivation of the Java plant. A few years after the introduction of this variety, two diseases appeared simultaneously in Bihar, the one due to an insect pest " Psylla " and the other the far more destructive " wilt " disease. Owing to the latter disease, which led to the partial or complete dying out of *khoonties* or the failure of seed plant, it gradually became impossible to obtain sufficient seed for general use. The problem of seed supply for Bihar has therefore received the attention of the Botanical Section at Pusa for some years. The Howards have devoted much time to the investigation of the root system of the Java plant and a new system of growing Java indigo, based on its results, has been worked out. The crop is sown in September (after a clean fallow) in double lines with a space between for mechanical interculture to keep down weeds and to aerate the soil. The lines are pruned as early as

possible after the rains break and the second cut is taken as soon as possible afterwards. The results obtained show that under actual field conditions the pruned plant, grown in double lines, shoots much faster and much better than the completely cut back plant. The results obtained were applied on a large scale during the year and very fine samples of seed were obtained. The best returns are obtained under conditions of garden rather than field cultivation and experiments on this subject are continued as it is expected to raise, under conditions of intensive culture, heavy yields of seed, no matter what the season may be. There is little doubt that the sooner North Bihar becomes self-supporting as regards Java seed the better. The Imperial Economic Botanists are also continuing their work on the selection of Java indigo. One of the early selections, Type 15, is being grown on four estates, while a number of others are being tested on a field scale and reserves of seed are being accumulated.

Madras has its own difficulties as regards the replacement of the Sumatrana plant by the Java variety. The principal one is that it is impossible to secure germination of the Java seed unless this is first treated with strong sulphuric acid. This is possible in Bihar where the cultivation is controlled by European planters, but this operation does not appeal to the Madras ryots and, when it was attempted, the germination results, probably owing to faulty treatment, were anything but good, and were not of a nature to impress the ryot with the superiority of the Java plant over the one the growing of which he is accustomed to and understands. Unless this preliminary difficulty can be solved there is no future for this crop in South India.

The agricultural side of the problem is however the more serious one. During the past few years the failure of second cuttings has become more and more general each year throughout Bihar, and in 1917 second cuttings failed on many estates where formerly moderate crops were obtained. The actual falling off of the crops in the past two years is seen from the follow-

ing figures taken from the indigo memorandum of the Department of Statistics :—

Year.	Area in acres.	Yield of indigo in cwt.
1916-17 . .	76,500	10,800
1917-18 . . .	85,900	10,300

Thus although the area under indigo increased in 1917-18 by 12 per cent., there was a fall in the total produce by nearly 5 per cent., that is, an actual loss in the past year of 17 per cent. Mention was made in last year's report of the Indigo Research Chemist's theory that the depletion of available phosphate in the soil was the principal cause of this situation and that by proper manuring it will be possible again to obtain the high yields of indigo which were given by the Java plant when first introduced into Bihar. A year ago from a detailed study of the indigo soils of Bihar Mr. Davis concluded that " unless superphosphate manuring is generally adopted, an enormous falling off in the output of natural indigo will occur during the next few years," just at the time when it is essential that produce should be at a maximum in order successfully to compete with the synthetic. Reports of the results of the season's working at various factories seem to justify the prophecy. In many cases the produce obtained was only about one half that obtained in the corresponding season last year. Even where there was a fair yield of actual green plant, very little dye could be extracted from it. In several cases the produce per acre was less than ten pounds of cake indigo from Java plant, which, compared with the yields of 60 to 80 lb. obtained in the early days of the Java plant in Bihar, is lamentably small. On the other hand, the very few planters who made trials with superphosphate manuring on their estates obtained favourable results not only with indigo but with other crops also. For example, on the Moniara estate comparative tests carried out with plant grown on land manured with superphosphate and san-hemp (*Crotalaria juncea*) and that on land under other conditions of treatment, showed that while on the former land the yield of cake indigo per acre was 64 lb. that under the other condition ranged from 32 to 12 lb. The one noteworthy fact noticed in these experiments was that though the growth of

green plant on land treated with nitrogenous manures was b rapid and abundant (152¼ cwt) the yield of cake indigo w only 22 lb. per 100 cwt. plant and compared unfavourably wi 57½ lb. on land treated with superphosphate. This seems justify the claim made that a combination of green-manuri with san-hemp and superphosphate is an ideal one to ensu not only a high yield of plant but also a larger amount of t dye. Some 20 to 25 planters have expressed their willingnes to make trials on their estates with superphosphate this season With the close of hostilities, the difficulties of getting a proper supply of superphosphate should not be insurmountable, and the results of these experiments will be awaited with considerable interest.

The possibility of improvement on the manufacturing side is discussed under the sections on Agricultural Chemistry and Bacteriology (pages 74 and 103). As regards improvement in methods of marketing it may be mentioned that a committee has already been formed at the India Office to advise on the subject and it is in close touch with the Bihar Planters' Association.

Tobacco. The number of cigarettes imported during the year was estimated at approximately 1316 millions as against 906 millions in the preceding year and 653 millions the pre-war average. This heavy increase was due to the enormous demand for army purposes. The imports of unmanufactured tobacco also increased. There was a large decrease in the imports of cigars. The total imports were valued at approximately one crore and seventy lakhs of rupees as against one crore and twenty-five lakhs in the preceding year, the annual average value of imports in the five years preceding the war being only 71 lakhs.

As mentioned in last year's report the problem in India is to evolve tobacco, either by selection or hybridrization, suitable for cigarettes.

A pure line selection of the Howards at Pusa, combining yield and quality, known as type 28, which is suitable both for cigarette purposes and also for general cultivation, continues to increase in popularity among tobacco growers. Three definite schemes of seed distribution have now developed in North

Bihar, in Burma and in the Central Circle of the United Provinces. Seed sufficient for 4,000 acres of new cultivation was distributed during the year. In the Tirhut Division of North Bihar the distribution of seed has been undertaken by the Indian Leaf Tobacco Development Company who give out the seed to any man who applies for it. There is no obligation on the part of any ryot taking this seed to sell the produce to the Company. In fact the growers find no difficulty in disposing of it to the Indian dealers. Seed for 800 acres has been supplied for distribution in two of the most important tobacco growing districts of Burma. It may be mentioned that three seasons' work at Hmawbi shows that Type 28 gives a finer leaf and is more suitable for cigarette making than the local types.

In the United Provinces seed of this type is being distributed among the tobacco growers of the Farrukhabad District where it is doing well.

The effect of different manures on the yield, quality and nicotine content of Indian tobaccos is being studied by Mr. J. N. Mukherji, First Assistant to the Imperial Agricultural Chemist, at Pusa. As regards yield, the best results were obtained by the use of farmyard manure, closely followed by a combination of superphosphate and potassium nitrate, whereas neither of the two latter manures had any appreciable effect when used alone. The leaf produced from the various plots was submitted to the Director of the Indian Leaf Tobacco Development Company, Dalsing-Sarai, for valuation as regards quality and nicotine content, but he was unable to detect any appreciable difference as the result of the specific manurial treatment. The relative effect of topping and spiking the plant was also investigated. The yield of plant in both cases was practically identical, but the topped plants gave a greater outturn of stalk than the spiked ones. The former, however, yielded a leaf of better texture and a higher nicotine content. An investigation contrasting the effect of rack-curing and ground-curing on the composition of the leaf showed that there is a destruction of starch and sugar during the process. It was found that ground-curing causes a greater reduction of the starch content than rack-curing and at the same time produces a leaf of higher nicotine content.

At the Burirhat Farm, Rangpur, in Bengal, experiments in the growing of Sumatra tobacco for cigar wrappers, comparison and selection from among the different varieties of tobacco and manurial trials are in progress. A few varieties of cigarette tobacco such as White Burly, Yellow Prior and Orinoco were grown with fair results. Many tobacco merchants offered a high price for the leaves and this year also even before the curing is complete they are competing keenly for the purchase of the leaves. A local variety has been found suitable for the Burma market and an attempt is being made to improve this. The services of a cigar roller have been obtained from Madras and good cigars are being made from the farm tobacco. The success of Sumatra tobacco on the Burirhat farm has led to an extension of its cultivation to the surrounding villages. With a view to popularize the cultivation of this tobacco among the ryots arrangements have been made to grow and cure the variety round about the farm. The value of green-manuring with cow-pea has been thoroughly established at Rangpur and is being demonstrated in the tobacco tract.

Oil Seeds. There was a remarkable fall in the exports of oil seeds from this country during the year under report. In fact they were the lowest on record since 1879-80. There was a decrease of 5 per cent. in exports as compared with 1916-17 and of nearly 68 per cent. compared with the prewar average.

Of the total quantity exported, linseed was 32 per cent., groundnuts 25 per cent., castor 21 per cent. and rape and sesamum together 16 per cent.

Linseed. The shipments of linseed (146,100 tons) were 63 per cent. below those of the preceding year and 61 per cent. below the pre-war average. The area under this crop, however, increased from 3,564,000 to 3,738,000 acres though the total estimated yield fell from 526,000 tons to 507,000 tons. It has not been possible to do any scientific work on this crop.

Groundnuts. 115,300 tons of groundnuts were exported, showing a decrease of 22 per cent. as compared with 1916-17. The total estimated yield of this crop fell from 1,196,000 to 1,042,000 tons, the area also having fallen from 2,334,000 acres to 1,894,000 acres.

This crop is of importance in Bombay, Madras and Burma, and is being introduced by the Agricultural Departments into other provinces as it is profitable and being a legume is good for rotation and for maintaining the fertility of the soil.

On the Palur farm in Madras the usual experiments on the rotation and manuring of the groundnut crop were carried out and single plant selections are being made.

In Burma trials with exotic varieties are being continued. The erect types—small Japanese and Spanish—promise well. Oil analyses have shown that the largest kinds have a lower oil content than the smaller seeded kinds.

This crop does well in Western Bengal on high land where the scarcity of water for paddy is most felt. Work was commenced in 1915, and in 1917 there were over 1,500 *bighas* under groundnuts in the Burdwan Division.

In Bihar and Orissa it is being pushed by the department. At Ranchi the crop yielded well with a rainfall of 40 inches but it suffered from *tikka* disease during the last two years. The Pondicherry variety however gave double the yield of other varieties. In the light sandy soils of the north of Bhagalpur Division also the crop suffers from disease.

As regards the increase of groundnut cultivation in other provinces, mention may particularly be made of the possibility of extending its cultivation on the *bhata* lands of the Central Provinces.

Sesamum. There was a considerable reduction in the exports of sesamum, which were less than one-fifth of those in the previous year. The area also fell from 5,023,000 to 4,342,000 acres and the estimated total yield from 513,000 to 386,000 tons.

In Burma work on this crop is in progress with a view to produce types of high yielding power in the localities in which they are grown. At Tatkon a number of types are under observation. Seed of a number of the most promising early unbranched types has been issued for trial under dry zone conditions. A branched type showing high yield and freedom from "green flower" is now grown on a field scale at Tatkon and a small quantity of seed has been distributed to cultivators in the vicinity of the farm. Oil analyses of 25 selected types carried

out by the Agricultural Chemist have not shown any significant differences.

Coconuts. The quantity of *copra* (the dried kernel of the coconut) exported was less than one-fifth of the pre-war average and the principal purchasers were the United Kingdom and France. Before the war Germany had the largest share in the trade. This crop is one of great importance in Malabar, Cochin and Travancore. It is estimated that in the Madras Presidency there are approximately 800,000 acres under coconuts of which 81 per cent. are on the West Coast. It was mentioned in last year's report that experimental stations have been started by the department on typical soils to study the crop. The work done during the year under report included a study of the germination of several varieties of nuts, and various indigenous methods of germinating them. In particular the root system was studied by dissecting out a series of stumps. It was found that the surface roots of a tree extended up to 21 feet from its foot but many roots appeared to go downwards at first and come to the surface at much greater distances. This raises considerable difficulties in the way of devising manurial experiments as it may happen that manures applied round one tree in a plantation also benefit a large number of other trees at considerable distances. It was demonstrated that coconut is mostly cross-fertilized and that the number of female flowers produced and the percentage of these that set fruit varies enormously from tree to tree. The very definite arrangement of succeeding leaves (double spiral, either right or left handed) has been demonstrated, each new leaf springing from the crown at an angle of 140° from the previous leaf. With the aid of this observation it has been possible to devise a system of registers in which careful records are being kept of the development of every leaf and fruit spike of selected trees. The yield of nuts of all the trees is also being carefully recorded. It is hoped that in course of time a thorough knowledge of the habits of the coconut tree will thus be obtained.

This crop occupies about 250,000 acres in Travancore and its importance to the State will be evident from the magnitude of her export trade in coconut products which are valued at one

crore and eighty-two lakhs of rupees. One of the chief defects of coconut cultivation in Travancore is overcrowding of the palms. The department is showing the advantage of reducing the number of trees planted per acre. Hybridizing experiments are also being carried on with a view to evolving varieties possessing high yielding and early flowering qualities with the largest possible quantity of oil in the kernel. Great possibilities in the improvement of coconut cultivation in this State lie in proper manuring. Very satisfactory results are obtained by using the manurial mixture recommended by the department, *viz.*, 10 lb. oilcake, 20 lb. ashes, 2 lb. fish refuse and 1 lb. salt with some lime.

Tea and Coffee. The area under tea rose from 649,000 acres to 664,000 acres and the estimated total yield from 368,429,000 lb. to 370,181,000 lb. The quantity of tea exported during the year was the highest on record, being 359 million pounds, which is an increase of 23 per cent. over the previous year and of as much as 35 per cent. above the pre-war average. The value of the exports amounted to 17 crores and 67 lakhs. The difficulties in obtaining tonnage were the controlling factor during the year. Of the total quantity exported from India 90 per cent. was from Bengal and 7 per cent. from Madras.

The Indian Tea Association maintain a Scientific Department which investigate all problems connected with this crop in North-East India. It issues a quarterly Journal in which useful instructions based on the results of the work done by expert officers are given to tea planters. Besides this quarterly, two publications on " Soil Denudation " and " Tea Roots " were published during the year. In Southern India the crop receives special attention from the Deputy Director of Planting Districts. *The Planters' Chronicle*, a weekly paper issued by the United Planters' Association of Southern India, meets the needs of the tea planting community in that part of India.

The total area under coffee in India is 223,195 acres. The chief coffee growing areas are Madras Presidency, Mysore, Coorg, Travancore and Cochin. Of these Mysore and Coorg contain 74 per cent. of the total. By far the majority of the coffee grown in South India is of the *arabica* variety. Of recent

years a certain amount of *robusta* coffee has been planted and this variety is growing in favour on poor soils and as a catch crop among *Hevea* rubber. It bears heavily but produces an inferior grade of bean. Since the establishment of the Scientific Department of the United Planters' Association of Southern India in 1909 the control of diseases and systematic manurial schemes have been widely adopted. Frequent applications of lime are found to be beneficial to coffee soils. Applications of soluble and basic phosphatic manures like basic superphosphate and basic slag have also proved beneficial. For many years it was the custom to apply nothing but a mixture of roughly crushed bones and poonac locally obtained with an occasional dressing of fish manure. But now the benefit of varying the manures applied and of supplementing them with occasional applications of potash has been realized. The coffee on many of the estates is very old and the strain has been allowed to deteriorate. No care has been taken in selecting seed from which to raise nurseries. One of the most important advances in recent years has been the realization of the necessity for better seed selection and the possibility of raising a new vigorous strain of coffee by hybridization along Mendelian lines. A hybrid now exists which has all the vigour of the old Coorg, is highly disease-resistant and bears much more heavily. This is now being grown on an estate scale and a great future lies before it.

The future of coffee in South India lies in the raising of good hybrid strains which will bear more heavily than the present coffee; in the replacement of the old worn out trees with these hybrids; and in combination among the planters to control the local coffee markets and prices and to develop and organize the local sales of India grown coffee as well as to do their own curing.

It may be mentioned that the Scientific Department of the United Planters' Association of Southern India is about to be reorganized and enlarged. It will be controlled by the Madras Agricultural Department under the Director of Agriculture. A coffee experiment station is being established in Coorg where a whole series of experiments will be undertaken to study manuring problems, cultivation methods and disease control and possi-

bly in future plant breeding problems. It is also proposed to add to the staff a Mycologist who will study the many fungi which attack planters' crops.

Rubber. The exports of rubber have remarkably increased since the outbreak of war and the total quantity shipped in 1917-18 amounted to 8,430,000 lb., the highest on record. This was nearly eight times the annual average exports during the pre-war quinquennium. Nearly seven-tenth of the exports went from Madras and the remainder almost entirely from Burma. In Southern India there are about 60,000 acres under *Hevea* of which about half is in full tapping.

In Burma the area under rubber is 63,567 acres which shows an expansion of 4,310 acres over the area reported for the previous year.

The diseases from which this crop suffers are the black-thread disease, the fruit-rot, the abnormal leaf-fall and a rot of the tapped surface. Work done on these diseases has been detailed below under Mycology and Plant Pathology (pages 83 and 84). An interesting article on the manuring of *Hevea* rubber has appeared in the *Agricultural Journal of India*, October, 1918, to which reference may be made by those interested in the subject.

Fruit. There are vast areas in Baluchistan and the North-West Frontier Province where the conditions are ideal for the propagation of fruit trees, and naturally the most important work done on fruit culture is in these provinces. A fruit experiment station has been established at Quetta since 1911. The three principal lines of work taken up by the Imperial Economic Botanists at this station are:—(1) the working out of a method of packing which will enable the fruit to reach more distant markets and to command a higher price; (2) organization of a supply of well-grown, budded trees of improved varieties at a reasonable price; and (3) devising of improvements in orchard cultivation, especially with a view to the saving of irrigation water. The special fruit boxes and crates suitable for transport on the Indian railways devised by the Howards have been readily taken up by fruit merchants at Quetta, but owing to the difficulties in importing crate wood from foreign countries

it has not been possible to meet the demand. It was hoped that the box boards prepared in India from locally grown timber would be considerably cheaper than similar supplies from Norway, Great Britain and Japan, but this expectation has not been realized. Indian boards have proved inferior to and considerably dearer than the imported material. The demand is likely to increase every year, and as soon as prices settle down the supply of boxes will be handed over to a local agency. Since the introduction of the new boxes and the concession given by the railways for free return of "empties," the number of fruit merchants at Quetta dealing in small well-packed consignments has increased very considerably, and this in turn has affected the demand for the available fruit. The amount of fruit is now insufficient for the trade and new orchards are springing up in all directions.

The indigenous methods of fruit culture in Baluchistan are very primitive. Large numbers of seedlings are planted instead of budded trees; little or no cultivation is given; no pruning is done and the fruit is not thinned. Though the number of different kinds of fruit which will grow in Baluchistan is considerable, the orchards are almost entirely composed of peaches, apricots and common plums. This was said to be due to difficulties in propagation. For some years past, trees had been imported from Europe to meet this difficulty, but the imported trees did not thrive and the fruit obtained was often disappointing. The solution of this problem has been found by the Howards in the adoption of better stocks, in the introduction of different methods of budding and in improvements in the management of the nurseries. It is now possible to issue budded peaches, nectarines and apricots one year after the stones are planted. These improved methods are described in *Quetta Fruit Experiment Station Bulletin* No. 9 published during the year under report. The demand for fruit trees from the Experiment Station nursery is so great that private enterprise will have to step in and arrange for the supply, and it is a happy sign for the future of the industry that two private nurseries have already been started at Quetta.

In the North-West Frontier Province an experimental orchard was started by the department at Tarnab in 1911, for

variety trials and tests in pruning, manuring, etc. When it first started work there was not a tree of a named variety of peach in the North-West Frontier Province and probably there was also no budded peach or plum in any private orchard. But now all this is changed. For several years to come well grown orchards of the new plums and peaches will not fail to realize Rs. 500 (gross) per acre for the actual growers. A bearing peach or plum tree carries from 80 to 160 lb. of fruit, very often much more, and there are 100 trees to an acre, while the market rate of Tarnab peaches and plums is from Rs. 8. to Rs. 10 per 100 lb.. With a view to study in detail the behaviour of the chosen varieties and the breeding of more new varieties, a new orchard has been planted during the year under report. Over 30,000 fruit trees were distributed free during the year from the nurseries. If there were no peach fly the Peshawar season for this fruit would extend over 180 days. The season now actually lasts 90 days only and until early varieties were introduced by the department the peach season finished in 45 days. The length of the plum season has also been extended from 30 to 90 days.

In the United Provinces experimental work was carried out at the Government fruit orchards at Chaubattia on the most suitable stock, varieties, tree culture, etc., and the best methods of packing fruit for transport to the plains. The latter were tested successfully by the despatch of considerable quantities of apples to Mesopotamia. A number of young apple and apricot trees were distributed to encourage fruit culture among small growers in the neighbourhood of the gardens. The new fruit orchards at Ramgarh are coming into bearing and will shortly be in a position to supply fruit of a good quality to the plains markets.

In the Central Provinces work is being done towards improving the cultivation of oranges and plantains. The ridge and furrow system has proved very satisfactory in growing plantains.

The Fruit Experiment Station at Shillong continued to make satisfactory progress. Good fruit including numerous varieties of apples and pears are being produced and the results are promising.

The work on mangoes, oranges, guavas and figs in progress for some years past in Bombay continues to yield good results. Moreover, a private grape-grower at Nasik has been conducting experiments in grafting the grape-vine. Grafting, by approach, a shy bearer on a prolific one has given very good results which are discussed in the *Agricultural Journal of India;* vol. XIV, pt. I.

Fodder Crops and Grasses. In a country where the bullock is the principal motive power for cultivation the question of fodder supply is of vital importance. More attention is being given to this problem in Bombay than elsewhere, and during the year under report important results were obtained. Experiments made on the Dharwar farm to increase the fodder supply have shown that the use of a power chaff cutter results in the saving of 25 per cent. of the total *kadbi* (dry *Sorghum* stalks); that maize can be grown for silage and removed in plenty of time to allow a crop of gram to be grown; that a variety of *kharif jowar* (*Sorghum*) which ratoons well can be cut green for silage in September and will give a fair grain crop from the ratoon; that grass and sugarcane tops will give a useful silage; and that lucerne, guinea grass and *sherari* (*Sesbania*) give useful additions to the fodder supply.

There are large areas of spear grass (*Andropogon contortus*) in the Deccan, and the problem of making the best possible use of it as fodder for cattle has been solved by the Bombay Department. Experiments with spear grass, carried out on the Tegur cattle farm in Dharwar District, have shown that if cut in the ordinary way when it is ripe and the spears have formed, the grass is not so nutritious, and it also injures the mouths of the cattle, but when it is cut at the time of flowering and before the spears have formed, it provides good nutritious fodder, silage and hay. Cut in flower with a grass-mower and collected with a hay rake and then siloed, it makes excellent silage. When the grass has been quite ripe, a comb specially devised for the purpose can be used for removing the spears. In a province where fodder famines are frequent, the addition of this widely growing but hitherto neglected herbage to the list of nutritious fodders should greatly relieve the situation.

Bombay is now in the grip of a fodder famine, and the scheme of creating local fodder reserves against famine referred to in last year's report has proved of great utility. The department have at Chharodi in the Ahmedabad District 20 lakhs lb. of hay, over and above that required for their own herd during the period of famine, and this is being distributed at cheap rates. Experience has shown that there is no difficulty in getting the land into order for mowing machines, and that, with machines and rakes, grass can be cut and stored as hay at the cost of only Rs. 2-8 per 1000 lb., the market value of which in famine time is Rs. 40. When more staff is available it will be possible to create similar reserves in the other two districts of Gujarat which are also occasional victims of fodder famine. The plant erected at Kopergaon in the Ahmednagar District for shredding and baling *kadbi* is working successfully, and it has been found that the storage of *kadbi* can be successfully undertaken, but a suitable unit for growing it on would be a 300 acre farm and not a 100 acre farm as at Kopergaon. As funds permit and machinery is available, the question of erecting similar plants in other suitable areas will be taken up.

In Madras, besides the study of indigenous grasses, the comparison between fodder sorghum, guinea grass, lucerne, etc., is being continued. A variety of lucerne obtained from Bagdad was tried at Hagari and Coimbatore and shows considerable promise. Experiments on converting an area of waste sand dunes into a grazing ground are in progress at Hagari. Careful conservation and the last two wet seasons have brought this on wonderfully, and the contrast between the well covered area within the farm fences and the barren village grazing ground outside is now most marked.

In the paddy area of Lower Burma where the problem is to get a fodder which will promote stall feeding and render grazing grounds—the foci of disease—unnecessary, guinea grass is doing well at Hmawbi. It does not die out in the hot weather and has survived even the sandiest soil there. In the dry zone the department has to find a means of relieving the damage done by the parasite *Striga lutea* to *jowar* or to discover a satisfactory and immune substitute for that crop.

In Bihar experiments with berseem have been started on the canal-irrigated areas in the Patna and Shahabad districts. The crop would be an immense boon if it could be successfully grown through the cold weather in the Sone canal area on the paddy fields that are otherwise unoccupied from December to May.

This crop has been found to be a very heavy yielder of green fodder in the North-West Frontier Province, but in years in which the growth is most vigorous very little seed has been obtained. With a view, therefore, of finding a variety of berseem which will produce seed more freely than the one at present grown at Tarnab, variety experiments have been laid down.

On the Sukkur farm in Sind berseem has proved an excellent cold weather crop after rice.

Progress continues to be made at Quetta by the Imperial Economic Botanists in the study of the various factors involved in the growth of leguminous crops and also in the better preparation and utilization of the resulting fodder. Baling experiments carried out by means of the Boomer press showed that both lucerne hay alone and *bhusa* and chaffed lucerne mixed in equal parts can be compressed to the Army standard for pressed *bhusa*. As regards keeping qualities, several bales made on August 1st, 1917, were opened during the first half of 1918 and the fodder in both the lucerne and mixed bales was found to be in perfect condition with no trace of sourness or mouldiness.

It may also be mentioned that interesting experiments on lucerne cultivation are in progress at several remount depôts and military farms, and Major Bruce, of the Saharanpur Depôt, and Major Matson, Assistant Director of Military Farms, Northern Circle, have recently published in the *Agricultural Journal of India* vol. XIII, pt. II; vol. XIV, pt. 1) very interesting results of their experiments and experience. Major Bruce writes that it is not quite necessary, as generally believed, to grow lucerne on the ridge system but it can also be successfully grown broadcast as a rotation crop. The trials and observations made by Major Matson at Cawnpore and Ambala have shown that lucerne can be established successfully without any irrigation on most soils of the Gangetic plain, and that where there is

sufficient moisture in the subsoil it will give a highly remunerative outturn throughout the winter and early summer, if the soil is of good quality and well drained. The outturn will not be quite as much as would be obtained from the same land under irrigation; on the other hand, the percentage of dry matter in the green lucerne is believed to be substantially higher when the plant is grown naturally than when forced by irrigation in a heated atmosphere.

Miscellaneous. In a country like India where tracts abound in which agriculture becomes impossible without irrigation, the importance of the investigation as to how water can be used to the greatest advantage and with the least possible damage to the soil will at once be apparent. Dr. Leather on the chemical and Mr. Howard on the agricultural side have both gone into the subject while agricultural and irrigation officers in the provinces have made some important observations, but further investigations on a systematic scale are still necessary. The soil and sub-soil, the climate, temperature, season and rainfall, the sub-division of fields, the hours during which irrigation is done—by night or day—the state of water courses, the land levels, and the skill and sense of duty of the cultivators are all factors that vary with every tract where irrigation is practised, and all these will have to be studied before really useful recommendations are made to the cultivators. The Board of Agriculture in India considered this question at its meeting at Poona and recommended the creation of a special staff for the study of the many problems connected with it. This scheme should take time to mature; in the meantime the Punjab Government have already decided to start a special farm for the study of the water requirements of different crops, but this it is impossible to initiate at once for lack of staff.

Among botanical investigations of minor importance may be mentioned the continuation by the Howards of the isolation of the numerous unit species which make up the gametic constitution of the four varieties of *Hibiscus Sabdariffa* described in the Botanical Series of the *Memoirs of the Department of Agriculture in India*, vol. IV, no. 2. As regards *Hibiscus cannabinus*, the other fibre on which the Howards are working,

favourable reports continue to be received of the behaviour of the improved Type 3. Systematic comparative trials between the local and Pusa varieties were made at four centres in Monghyr by the Bihar Department and in each case the latter gave a heavier yield of fibre.

The Fibre Expert is conducting experiments at Dacca with the object of enabling sann-hemp to take the place of flax in canvas, shoe-makers' thread, etc. Besides the apparatus at Dacca, experimental plant is being put up by two Calcutta jute mills to test the process. From the material thus produced on a large scale it will be possible to judge whether the process is successful and if so it will be of far-reaching importance as being likely to bring another industry to India. Moreover the increased cultivation of sann-hemp, which is a legume and therefore an absorber of nitrogen from the air, would proportionately benefit the land on which it is grown.

As the result of several years' work on *sida*, a plant having fibre decidedly finer in texture and more glossy in appearance than jute, a pure line has been isolated at Dacca which is free from the bushy habit and so is suitable for cultivation as a fibre crop. As this is a high land plant and is capable of producing a good crop when sown after the break of the rains, Mr. Finlow is trying to introduce it in the Central Provinces where the climatic conditions are believed to be suitable. Its fibre fetches 20 per cent. more than the market rate for "first marks" jute and any quantity can be disposed of in Europe at prices bearing a similar proportion to that of jute.

Pusa grams Nos. 17 and 18 are doing quite well in the United Provinces and also the Central Provinces. They have been found to be both vigorous and heavy yielding grams.

The work on the sun-drying of vegetables carried on by the Howards and referred to in last year's report has aroused considerable interest throughout India. It may be mentioned that the Howards' method of sun-drying vegetables has been described in *Quetta Fruit Experiment Station Bulletin* No. 8. Samples exhibited at the All-India Food Products Exhibition at Calcutta received a special prize, and considerable interest was

evinced in the exhibit by visitors. As the only way of finding the value of a new thing is to sell it, arrangements have been made to place sun-dried vegetables on the market. The fresh material now available at Quetta is not the best possible for sun-drying and the yield is somewhat low. Arrangements have therefore been made at the Fruit Experiment Station to work out the best methods of vegetable growing applicable to local conditions.

In the United Provinces, botanical experiments with poppy were directed towards determining how far the power of the plant to produce a particular alkaloid is hereditary. It has been satisfactorily established that the varieties grown in certain areas are characterized by a low morphine content, and Mr. Leake has isolated types which, when tried on a field scale, have proved uniformly rich in morphine. The agricultural problem is to substitute these for the varieties most grown.

Among the dry crops *jowar* is the most important, the area under it being only second to wheat. It is principally grown in Bombay, Madras, Mysore and the Central Provinces, and the local Agricultural Departments have been devoting attention to both the botanical and agricultural aspects of the crop. In Bombay mass selection of good heavy seeded *jowar* has given good results and there is a growing demand for such seed. Experiments made at Surat have shown that night-soil considerably increases the yields of this crop. In Madras single plant selections are being made at Hagari and Nandyal and the best retained for further trial. In the Central Provinces artificial crosses have been made between different types of *jowars* with the object of studying unit characters on Mendelian lines.

Ragi (*Eleusine coracana*) is another important dry crop of the Peninsula. In the Madras Presidency work on this crop is being done at Hagari. Of the strains isolated No. 8 has proved to be the best yielder and its adoption will now be advocated. In Mysore improved strains giving 20 per cent. more yield have been established. Private seed farms are being organized all over the State for growing pedigree seeds for general distribution. Further selection work is also in progress.

(*b*) Agricultural Chemistry.

The importance of chemical research in connection with agriculture is self-evident and fully recognized. There is not a single province to-day, with the exception of the North-West Frontier Province, which has not an Agricultural Chemist of its own. Besides these officers, an Indigo Research Chemist is engaged at Pusa, while a special officer is working at Cawnpore to improve the medicinal value of Indian opium.

Soils. The importance of systematic soil surveys to the cause of Indian agriculture cannot be over-estimated. The elaborately organized work of the American Bureau of Soils is an example of what a systematic survey can do for the agriculture of a country. The productive capacity of the soil and its peculiarities must always be the first consideration in applying scientific methods to agricultural practice, and it is only with such knowledge at its disposal that the Agricultural Department can hope with confidence to educate the cultivator in the best methods of working and the most suitable crops for his conditions. Besides the direct profit to the cultivator for which the work of the American Bureau of Soils has been responsible in suggesting new and more profitable crops in localities where they had not previously been introduced and in explaining and indicating the remedies available for the treatment of infertile soils, the accumulated results of years provide most valuable data for the soil scientist all over the world. Further, these soil surveys should prove of use to the Revenue Department especially in connection with Settlement and the question of introducing canal irrigation in tracts which are barren or uncolonized.

The work done on soil surveys, analysis of typical soils and reclamation of saline or sterile lands in the various provinces may now be noticed.

In Bengal considerable progress has been made with the provincial soil survey. Compared with the silts, the red soils show a general deficiency in phosphoric acid and lime in Western Bengal and of potash also in Eastern Bengal. Alongside the soil analyses an examination of the ash of typical crops is being carried out and very interesting figures are being obtained, show-

ing the wide differences in mineral composition which the plant is capable of withstanding.

A systematic soil survey of the south of Bhagalpur District has been started by the Agricultural Chemist to the Government of Bihar, and an examination of some of the soils collected appeared to indicate an absence of phosphoric acid. In North Bihar the results of Mr. Davis' experiments on indigo soils point to an actual deterioration of these soils having taken place as the result of depletion of phosphates.

As stated in last year's report the Punjab Government have been so much impressed by the success of the reclamation by the late Dr. Barnes, of the alkali soils at Narwala by deep cultivation, draining and washing, that they have sanctioned a scheme for applying the methods of Narwala to the reclamation of Crown lands on the Lower Bari Doab canal on an extensive scale. A block of 625 acres having the required diversity of soils was allotted during the year for the institution of an experimental farm for the purpose of research work on the various types of sterile soils met with on the canal. Besides this an area of 1,000 acres has been selected for the trial of Dr. Barnes' methods and an additional allotment has been made for the trial of reclamation by bullock power and for leases to selected cultivators who will work under the direction and control of the department.

Pot culture experiments made at Pusa with the object of testing the growth which could be induced in the *barra* sterile soils by washing out the salts present with the ordinary well water of Pusa, have shown that under certain conditions there is a possibility of forming " black alkali " in the soils on irrigation with a hard water. Pusa well water contains a considerable amount of bicarbonate of lime, while the soils experimented with originally contained a comparatively small amount of alkaline carbonate and a considerable proportion of sulphates and chlorides. After the washing process, the sulphates and chlorides in the soil were reduced but the carbonate content considerably increased, with the result that the original condition of white alkali was changed into that of black alkali and germination was practically entirely inhibited. The danger of black alkali forming in calcareous soils has recently been the subject of

investigation in America, but no attention has hitherto been drawn to the danger of employing a water containing calcium bicarbonate in solution for the irrigation of lands showing white alkali. Whether these factors will prove responsible for the infertility of the soils under cultural conditions will be proved when field experiments are put in hand. Another factor which has a profound influence in modifying the texture and consequently the culturability of the soil is to be referred to the deflocculated nature of the clay. Two methods for the investigation of this factor are being tried, and the results seem likely to prove of importance and to conform to observations recently made by American investigators.

In the Central Provinces a series of pot experiments were carried out to ascertain whether the lateritic (*bhata*) soil to be found in Chhattisgarh is deficient in any of the essential plant foods. That it is deficient in nitrogen is already known, but recent experiments have proved that it is also deficient in phosphates.

In Mysore an examination of a number of representative samples from the Marthur and Babbur farms has shown the extreme poverty of some of these soils especially in lime and phosphoric acid.

A report on the extent and character of the saline lands of the Madras Presidency by Dr. W. H. Harrison has been published in the Madras Year Book, 1918. The saline soils of the Presidency, although amounting in the aggregate to a considerable area, are in general found in comparatively small isolated tracts and in the deltas. A bulletin on the soil survey of the Kistna District is now nearly ready for publication. The soil survey carried out in the Tanjore delta has shown that there is a great need for some form of phosphatic manuring in these soils.

In Burma work on soil acidity was continued by Mr. Warth and the enquiry into the phosphoric acid requirements of some Lower Burma soils was brought to a conclusion. A Memoir on the subject is now in the press.

Dr. G. D. Hope, Chief Scientific Officer of the Indian Tea Association, has made a study of the tea soils in North-East

India. The results of his observations have been published in the Special Science Congress Number of the *Agricultural Journal of India*, 1918.

Manures. The principal manurial substances used in India are cattle manure, household refuse, ashes, soil from old village sites, tank and river beds, oilcakes, fish manure, nitre-earth, saltpetre and lime. Leguminous crops which do so much to restore the fertility of soils are generally grown in rotations and the practice of green-manuring is being introduced by the department into districts where it was previously unknown. Better conservation of cattle urine and farmyard manure is being demonstrated to cultivators. Artificial fertilizers such as Chile saltpetre, ammonium sulphate, superphosphate, bone-meal, etc., are used in an increasing measure by planters and intelligent ryots. In Bombay it has been proved that for valuable irrigated crops a substantial profit can be realized by the use of artificial manures. On the other hand, all indications go to show that for ordinary irrigated field crops the profit from artificial manures is very problematical even in tracts which ordinarily have a good rainfall, while in the tracts of more precarious rainfall their use for unirrigated crops is out of the question. For ordinary field crops in tracts of good rainfall nothing gives such good results as farmyard manure. As regards nitrogenous manures there is always a ready response from crops by the application of some quickly acting nitrogenous material, like nitrate of soda, which is marked by the intense green colour on the foliage and the pushing on of growth, but an over-dose of nitrogen tends to lateness of ripening. A large demand for sulphate of ammonia is springing up among sugarcane growers in the Deccan. Nitrate of lime and nitrolim are being imported into Madras in increasing quantities.

The investigation started by Dr. Harrison some years ago at Coimbatore as to the relationship of the gaseous products of decomposition of green manure in paddy soils has practically reached the final stage. It has been shown that the carbon dioxide and hydrogen produced during the decomposition are recombined under biological influences, and that the action is of such intensity that the absence of these gases from the atmosphere in anything but small quantities is accounted for. Indi-

cations have been obtained showing that marsh gas can be produced by a combination of these two gases under biological influences. This phenomenon can account for the accumulation of nitrogen gas in these soils and has a considerable bearing on the question of lime conservation. It has also been ascertained that this reaction between carbon dioxide and hydrogen is not peculiar to paddy soils, but that it can be induced in dry soils with the utmost ease when the conditions are approximately anaerobic in character.

The same officer has taken up at Pusa the investigation of the question whether or not the use of ammoniacal manures could be advantageously combined with green-manuring in connection with the paddy crop. From the work done so far it appears that the uncertain reaction of green manures is not associated with soil conditions, but that the strain of paddy employed is a factor to be considered. This problem requires close investigation and in future, work on this crop will form one of the major subjects of investigation of the Chemical Section at Pusa.

Of the other essential fertilizers phosphatic manures come next in importance. The manurial experiments with superphosphate initiated by Mr. Davis on the indigo soils of Bihar have shown the great value of this fertilizer on these soils. Best results are obtained when the land treated with super is also green-manured with sann-hemp.

In the Central Provinces there appears to be no need of phosphate in the black cotton soils. On light soils it has proved valuable in the case of paddy, sann-hemp and sugarcane.

As the mode of action of superphosphate in calcareous soils is somewhat obscure, Dr. Harrison has started an investigation to obtain information regarding the combinations formed, the rapidity of their formation, and the consequent effective range of superphosphate applications. Preliminary experiments in relation to the reactions occurring between phosphates of lime and calcium carbonate under varying conditions showed that superphosphate reacts very rapidly at ordinary temperature with calcium carbonate, the product of the reaction being the comparatively insoluble dicalcicphosphate and that the latter

in turn slowly reacts with more calcium carbonate, forming tricalcicphosphate. At higher temperature tricalcicphosphate is directly formed with great rapidity. The fertility of these calcareous soils therefore becomes largely a question of the solubility of this latter substance in the soil solution. This deduction is of considerable interest, and experiments are being conducted to test its validity.

At the last meeting of the Board of Agriculture in India the committee which discussed the subject of phosphatic manures recommended to the attention of workers the question of investigation of forms of phosphatic manures other than superphosphate, as there seemed to be distinct evidence in India that the less soluble phosphates, particularly in conjunction with bulky organic manures, are of great value. In Madras experiments relating to the availability of powdered phosphatic nodules in paddy soils have reached a fair stage of completion. The phosphate which was obtained from Trichinopoly has not been found suitable for the manufacture of superphosphate, but the results so far obtained generally indicate that green manure increases the availability of the insoluble phosphate. Some of the experiments, however, require to be repeated before any definite statement can be made. Mr. Taylor has been endeavouring at Sabour to find some cheap method of rendering apatite soluble. Further experiments during the year under report have shown that the quantity of iron in the sample of this mineral under investigation is so large as to render it difficult to make superphosphate from it without further treatment. It is probable that if electricity were cheaply obtainable (such as would occur in the neighbourhood of some large waterfall) the Palmaer patent process would be of use in rendering this very insoluble phosphate readily available. The process is easily workable and Mr. Taylor has obtained, by this means, soluble phosphate from the apatite under laboratory conditions. It is, however, obvious that such work would have to be done by water-power, as electricity obtained from any other source would be too expensive.

Third in importance come the potassic fertilizers. Indian cultivators generally use wood ash to serve the purpose. Besides this there is saltpetre and nitre-earth. Experiments have also

shown that there is very little need for potash fertilization for many crops especially in the black soil areas of India. But to get the best results, potash manures are indispensable for tobacco and some garden crops in sandy land. In parts of Bengal, however, the soil is deficient in potash and here the water hyacinth which has become such a serious pest can be most profitably utilized to this end. In fact, Mr. Finlow's recommendation that this aquatic plant can most economically be exterminated by drying and burning it and selling the ash as manure for its potash content, has caught on in a surprising manner and the production of ash is now described by independent observers as widespread. A detailed survey of the affected districts was made during the year in regard to the richness in potash of the water hyacinth growing in them. It was found that, except in the red soil tract, the ash of good plants contains a minimum of about 18 per cent. of potash and that upto 45 per cent. is found in the best ash. The potash content has been found to be in direct ratio to the vegetative growth. People are therefore strongly advised not to produce ash for sale from a stunted plant, but to apply it to their own fields which are poor in potash. It has further been observed that plants growing in deep water grow better and therefore contain more potash than those growing in a few inches of water and sending their roots down into the ground. For the production of ash for sale farmers should therefore take their plant from deep water, such as the water courses, whose navigation is being impeded by the hyacinth. Moreover, while the living plant appears best able to absorb potash from water, the dry plant loses its potash very easily, by mere washing with water or by exposure to a shower of rain. Preliminary experiments have been started by Mr. Finlow with a view to ascertain whether it is possible to obtain more or less pure chloride of potash from the water hyacinth ash .

Of the calcareous fertilizers lime is useful in correcting soil acidity and stimulating nitrification and hastening the formation of soluble plant food in soils. It also improves the texture of soils. The advantage of using this fertilizer especially in the sour soils of Assam has been amply demonstrated by Mr. Meggitt. The manurial experiments at Jorhat have also

shown the evil effects of applying superphosphate without lime on these soils. Many soils in South India, of which those of the Nilgiris and the West Coast may be instanced as types, are very deficient in lime and would be greatly benefited by heavy dressings of this substance. The soils of several of the districts and portions of some of the deltas of the Madras Presidency, although not depleted to the same extent, have a very low lime content and would be materially improved by lime manuring.

Sugarcane. The question whether storing of canes by clamping in the North-West Frontier Province has any deteriorating effect on juice content has been engaging the attention of the Imperial Agricultural Chemist for some years. The conclusion arrived at, that no deterioration took place, was confirmed during the last cold season. The effect of windrowing* cane as practised in Louisiana was also examined. The analytical values obtained with the two canes Ashy Mauritius and local Pounda showed that as a result of windrowing at low temperatures for four months there was a decrease in the percentage of juice but its purity tended to increase rather than decrease. Windrowing will therefore not lead to the introduction of increased difficulties in the production of white sugar. An attempt was also made by carefully checked weighings of the canes and juice produced to determine whether windrowing led to a loss of sugar, and it appeared that there is an actual loss, though comparatively small, in the case of Ashy Mauritius canes, but that in the case of local Pounda there is a marked increase. This fact is of great importance and requires confirmation before being accepted, but if confirmed it opens out a field for further investigation.

Mr. Somers Taylor has, besides carrying out the analysis of canes on the Sabour and Sipaya farms, demonstrated the presence of aconitic acid in the sugarcane by means of a new colour-reaction with acetic anhydride, and has actually isolated the substance in small quantity. The conditions determining its formation have also been studied.

In the Central Provinces, the analysis of Sunnabille cane planted at different times on the Tharsa farm was continued.

* Digging and laying canes in rows on the land.

The results of the last five years have proved conclusively that early or late planting has no effect on the date of maturing. This always occurs in February.

Tests regarding the effect of the addition of different quantities of lime to sugarcane juice before boiling, on the colour, composition and keeping qualities of *jaggery*, were conducted in Mysore with all the varieties of cane grown on the Hebbal farm, and the results were in general similar to those obtained in the previous year. The addition of enough lime to the juice to render it just neutral to litmus paper and one-fourth in excess of this quantity gave the best results.

Indigo. As stated in last year's report the loss of indigo caused by bad settling can be obviated by the use of *dhak* (*Butea frondosa*) gum. The trials made at several factories have shown that increases of 8 to 16 lb. of cake indigo per 100 cwt. of plant can be obtained by the use of this gum without any appreciable deterioration of quality. These results have been published in *Indigo Publication* No. 3. Mr. Bhailal M. Amin, First Assistant to the Indigo Research Chemist, has succeeded in evolving a simple process for extraction, in a large quantity, from the Java indigo plant, of indican, the parent substance in the indigo leaf, from which the indigo blue of commercial value is obtained. This substance is required in a pure state to test the existing methods for the analysis of the indigo leaf and also to ascertain the action of the enzymes and bacteria which produce the indigotin from it. A knowledge of the chemical and physical properties of this glucoside is therefore one of the important factors in the improvement of indigo manufacture. Hitherto, however, all investigators had failed to get at it in a pure state from the Java plant, and such specialists as Bloxam and Rawson had described it as an "elusive substance." The fact that indican can now be readily obtained is of considerable scientific value and will greatly simplify future work on indigo. The method is described in *Indigo Publication* No. 5. For bacteriological work done on this crop, especially Mr. Hutchinson's discovery that the yield of indigo can be greatly increased by inoculating the steeping vats with proper bacteria in suitable numbers, reference may be made to page 103.

Dairying. A small dairy experiment was commenced in 1914 on the Mandalay Experiment Station to ascertain what simple improvements commensurate with villagers' finances, such as the use of separators and churns, etc., could be introduced into the *ghee* making industry in the Ava tract of the Sagaing District. The experiment has shown that the use of the separator and churn is much more economical in time and labour when quantities like 60 lb. of milk are concerned than the use of the separator only or the country methods and that a larger amount of hard cheese is thus produced than by the country method. The effectiveness of ripening by starters has also been proved. The results of this experiment have shown that if co-operative purchase of separators and churns is undertaken it will be advantageous to the industry.

A large number of analyses were carried out at Nagpur to ascertain the changes in the composition of milk and butter fat due to seasonal variations and changes in feeding. The specific effect of the three common oilcakes, *viz.*, linseed, cotton, and sesamum, on the composition of milk and butter fat was also studied. Feeding with sesamum cake reduced, whereas linseed and cotton cakes either maintained or increased the percentage of fat. Definite schemes of experiments were also drawn up to determine a cheap and good food mixture for milch cattle and to find out the optimum ratio of concentrated food for milk production. The figures obtained so far indicate that the best results are obtained when the quantity of concentrated food given is 60 per cent. of the milk yield. It would appear from the experiments at the Nagpur College Dairy that the introduction of the cream separator in *ghee*-producing districts would add largely to the output; but the Indian churn is as efficient as an improved barrel churn. Experiments were also carried out to see whether surplus milk in a small dairy can be profitably utilized for cheese-making. Some 765 soft cheeses were manufactured during the cold weather and being of good quality they found a ready market. An article on the subject by Messrs. Allan and Takle has been published in the *Agricultural Journal of India*, vol. XIII, pt. IV.

Miscellaneous. Among other chemical investigations of importance may be mentioned the work done at Sabour on the

cyanogenetic glucoside in *jowar*, and on the prussic acid content of Burma beans by Mr. Warth. In regard to the former, experiments were carried out with a view to find out the effects of different times of planting on the quantity of hydrocyanic acid developed in *jowar*. Some very striking results were obtained. It was found that stunted plants do not, as was originally believed, contain the largest percentage of the poison. Well developed plants under certain conditions of growth actually contained larger quantities of the acid than stunted plants in the same plots. The time of planting by itself had no effect on the accumulation of the poison, but a crop planted late showed much greater chance of being less poisonous than one planted early. For full particulars reference is invited to the *Agricultural Journal of India*, vol. XIV, pt. 1.

As regards the latter investigation a paper on some preliminary results obtained has been published as *Pusa Bulletin* No. 79. It may be mentioned that the presence of prussic acid in Burma beans and the danger arising from their use for human consumption has recently attracted the attention of London importing firms who have pointed to the poisonous character of occasional cargoes, and a suggestion was made that the Burma Department of Agriculture might encourage the cultivation of non-toxic varieties. An attempt was made to meet this suggestion by importing Madagascar beans, but this strain was found unsuited to local conditions. Mr. Warth had then to fall back on the varieties locally grown, and he collected a number of single plant samples of typical beans and grew them as pure strains at three different agricultural stations situated in distinct agricultural zones for testing the prussic acid content. These trials have shown that (1) the hydrogen cyanide content varies considerably according to soil and climatic conditions but it is an inherited character of single plant cultures; cultures which give low amounts of hydrogen cyanide in one locality give low figures under all the conditions tested; (2) that differences in colour in seeds from a single culture do not indicate differences in the power of producng hydrogen cyanide in their progeny; (3) that the best cultures so far found always contain some hydrogen cyanide though the quantity is only half that contained in the original sample of Madagascar bean imported into the province

as safe. It therefore appears that by means of a careful chemical selection pure strains can readily be obtained which are quite safe for human consumption and which will retain this characteristic under varying cultural conditions.

An important feature of the exhibition held in Madras during the Christmas holidays of 1917, was a large variety of exhibits displayed by the Agricultural Chemist showing that all manner of foodstuffs and other materials ranging from patent breakfast foods, invalid foods and malted milk foods to photographic printing art paper, washable paint and boot polishes, could be made from materials available in the country. In this connection the work done on malt and malt extract which form important constituents of many patent foods is of great importance. Barley is the cereal grain most universally used for the production of malt, but as it is not grown in South India with the exception of a comparatively small quantity on the Nilgiri hills, a substitute for barley was sought for amongst the important grains of the Presidency. The results so far arrived at are that *cholam* (*Sorgum*) malt extract hydrolyses soluble starch at a greater rate than barley malt extract; that in the case of hydrolysis of starch by *cholam* malt the proportion of dextrine to sugar produced is greater than in the case of barley malt compared under identical conditions, and that the products of such hydrolysis by *cholam* malt consist, as with barley malt, largely of maltose and dextrine. Further experiments are necessary but it is justifiable to claim that *cholam* can be used wholly or partially as a substitute for barley in malting operations. The absence of a sufficient proportion of husk in the grain is perhaps a disadvantage with *cholam*, but this defect can possibly be remedied by admixture with malted paddy or paddy bran. If we remember that *cholam* is, according to the area grown, the third principal crop of the Indian Empire and that it is much cheaper than barley, the value of this investigation to the brewing industry in this country can be easily imagined. For further details regarding the preparation of the malt and its food products a reference is invited to the *Memoirs of the Department of Agriculture in India, Chemical Service*, vol. V, no. 4, and the *Agricultural Journal of India*, vol. XIV, pt. 1.

(*c*) Mycology and Plant Pathology.

The damage caused to crops by fungi is so great that one of the chief desiderata of Indian agricultural activity is to develop means of reducing this damage. Disease can be avoided by the use of more resistant varieties, by proper rotations, by seed and soil disinfection or by the application of sprays. But the practicability of the remedy from an agricultural and financial point of view is of first importance. It is no use telling a ryot to do a thing which he cannot afford to do or for the execution of which agricultural skill or labour is not available.

To treat even the simplest disease with confidence in the result, it is necessary first to know the cause of it, the life-history of the parasite, and the circumstances which influence the establishment of parasitic relations between it and the host. These fungi are so minute that they cannot be seen by the naked eye, and cultivators are slow to grasp the extent of the damage they are capable of doing. This ignorance and the attitude of patient resignation invariably adopted with regard to diseases too often hampers the successful carrying out of organized methods of control. If it is necessary to cut off and burn shoots of an internally diseased tree like a palmyra palm, or to eradicate heavily infected trees with a view to stop the further progress of the disease, the ryots will not agree to it, but place obstacles in the way. They do not realize the fact that the right attitude to be adopted is one of active warfare against these diseases, that all should combine to eradicate the disease in the locality, that it should not be allowed to spread; that, above all, as prevention is better than cure, the possibility of introduction of new diseases should be guarded against. Nothing but protective legislation will overcome the apathy and indifference of the cultivators.

The year under review was marked by the passing of an order, under the Destructive Insects and Pests Act, regulating and restricting the importation of plants and seeds into British India. By the provisions of this order no plant may be imported into British India through the letter or sample post, and the importation of plants other than fruit and vegetables intended

for consumption, potatoes and sugarcane is restricted to certain prescribed ports, where fumigation with hydrocyanic gas can be carried out. Since fumigation, although satisfactory in the case of insect pests, is not an efficient method of killing fungal parasites in seed and plants, the importation of fungal disease is provided against by a series of clauses regulating the introduction of potatoes, sugarcane, rubber plants, coffee plants, coffee, flax, berseem and cotton seeds. This list includes the plants and seeds on which the introduction of dangerous fungal diseases into India is most probable, and the provisions of the notification ensure that these plants shall only be introduced if accompanied by a certificate from a competent authority in the country of export stating that they are free from certain fungal parasites. In the case of coffee plants and seeds importation may only be made by the Madras Department of Agriculture.

Another important event of the year was the issue of Dr. Butler's book on "Fungi and Disease in Plants." It supplies a long felt want in the literature of scientific agriculture in India, and will be highly valued by those who are interested in the war against fungi and diseases in plants.

The work done on the diseases affecting various crops may now be reviewed.

Diseases of Paddy. It has been mentioned in previous reports that the most important disease under investigation in the Mycological Section at Pusa, is that locally known as *ufra* in Eastern Bengal, which causes damage amounting to lakhs of rupees.

The districts actually known to be affected are Noakhali, Tippera, Dacca, Faridpur, and Backergunge, containing nearly 6 million acres out of the 21 million acres under this cereal in Bengal. Adjoining them are other districts so similar in climatic conditions and agricultural practices that they are liable to infection, and, indeed, in some cases they have already been infected. This threatened area adds another 6 million acres of rice in Bengal and over two millions more in Sylhet (Assam). In all this vast area rice occupies over 70 per cent. of the cultivated land, hardly any alternative food crop is grown, and the great bulk of the tract is totally unsuited to any other.

Hence it is probable that no plant disease hitherto observed in India, except the cereal rusts that periodically take heavy toll of the wheat crop in Northern and Central India, possesses such potentialities for harm as *ufra*.

Of the three main classes of paddy grown in Bengal, those principally suffering from *ufra* are the broadcasted *aus* (autumn paddy) and *aman* (winter paddy) grown on lower land and harvested during the moister half of the year from July to December. The transplanted varieties grown on relatively high land and the *boro* or spring paddy generally escape the disease. It has been proved that the disease is caused by the microscopic eelworm *Tylenchus angustus*. This worm hibernates in the stubble which it is the practice in the infected areas to leave in the fields after harvest. The worm cannot migrate so as to reach the upper parts of the rice plant where alone it can feed, in dry air, but does so readily when the humidity of the air reaches saturation point even though there is no film of free water on the plants. It has also been found that worms, preserved dry, retain their vitality, and are able to renew active motion after at least eight months, while those kept in moist air remain alive for about four months and those immersed in water for only a month or two.

Amongst the factors which control the wanderings of the worm in search of the food that it can only obtain from the living paddy plant, some, such as humidity, are *absolute* in that they impose conditions which rigidly limit the power to move, while others are *relative* in that they act through the instinctive or other vital processes of the worm and so influence its movements indirectly and are more variable in their action. It has been found from pot cultures at Pusa and a field experiment at Dacca that this disease can sometimes be conveyed by seed from an infected crop.

Destruction of stubble of the winter rice, supplemented by a sufficient period of good cultivation of the soil before sowing the new crop, is the remedial measure advocated, and demonstrations were carried out in Dacca and Faridpur districts. Mr. Milligan says that the problem is at root an agricultural one, the disease appearing as the result of an inferior method

of cultivating the *bhils*.* In addition to the standard check on the disease of stubble-burning, two lines of work are suggested—

(1) the improvement of *bhil* cultivation generally.

(2) the avoidance of the deep water crop altogether for one year and the substitution of another for it so as to starve out the parasite within a given area.

Work on both these lines has been started by the Bengal Department of Agriculture.

A Memoir by Dr. Butler giving a detailed account of the present state of our knowledge of the disease is in the press.

In Madras the disease known as *blast of paddy* was reported from some villages in Tanjore as attacking a particular variety of paddy—Korangu Samba—which the ryots had recently introduced into the delta on account of its high yield. In many cases the yield of grain in the affected crop was not more than one-twelfth of a normal crop. The disease was due to the fungus *Piricularia oryzæ*. Luckily most of the ordinary varieties appear to be immune and the ryots have been advised not to sow the variety Korangu Samba again.

Black Band Disease of Jute. In 1917 this disease of *Corchorus capsularis* was widespread in Bihar. It is due to the fungus *Diplodia Corchori* Syd. As the seed grown in Bihar was intended for distribution in Bengal, experiments were made with a view to find out the best method of killing the spores of the fungus without injuring the germination of the seed. Steeping for 10 minutes in a 2 per cent. solution of copper sulphate was found successful in this respect. The same fungus was also found in the jute seed crop grown at Kamrup in Assam. It appears that the late sown crop is relatively immune from attack. All field observations suggest that in some way the incidence of the disease is dependent upon the host plant reaching a certain stage of maturity and size and thickness of stem. Field and laboratory experiments are being continued by Dr. Shaw at Pusa with the object of elucidating the conditions which

* Basin-like depressions which always hold water in the rains.

favour the spread of the disease and any further methods of control. Further observations and experiments on *Rhizoctonia* on jute and its relation to this new disease are also being made by the same officer.

Diseases of Palm Trees. A disagreeable feature of the year was the discovery of a serious recrudescence of the bud rot disease of the palmyra palm in certain villages in Kistna and Godavari, which appeared to have been freed from it as the result of operations carried out in previous years. Steps have been taken to deal with the matter. The last two years were years of heavy rainfall in these districts, which was all in favour of the fungus, with the result that there was not only an increase in the percentage of dead trees but also a recrudescence of the disease in areas once free.

As the examination of trees, involving in all cases the cutting off of a certain number of leaves with their stalks, means some trouble and expense to the owners of trees, and as they do not fully realize the benefits of the work, the Madras Government have undertaken legislation and with its passing into an Act the problem of dealing with the disease must be much simplified.

Spraying operations against the *Koleroga* disease of areca palms continued in Malabar and Mysore and some parts of North Travancore. As the actual growers of the areca trees in Malabar are often rack-rented sub-tenants with no capital, endeavours are being made in conjunction with the Co-operative Department to enable them to purchase sprayers jointly or to rent them. In Mysore one village was brought under the Pests Act and the gardens treated against *Koleroga.*

The bleeding disease of the coconut palm has been found to be increasing in the districts of Tanjore, Madura, Ramnad and Tinnevelly. A fungus similar to *Thelaviopsis ethaceticus* Went. as described by T. Petch has been found commonly on the rotten parts of the trunk. It is being studied by Mr. McRae, the Government Mycologist.

In Travancore work was continued against the root disease, bud rot and stem bleeding disease of this palm. There is nothing fresh to report.

Diseases of Tea and Coffee. Investigations on fungi attacking the roots of the tea plant were carried on by the Scientific Department of the Indian Tea Association, and the life-histories of two fungi, *Rosellinia bothrina* and *Sphærostilbe repens*, were worked out. The die-back disease, brown blight and rim blight of tea were also under investigation and tests were carried on to ascertain the value of proprietary spray fluids.

In South India, brown blight continued to be frequently reported, especially on nurseries, but the recommendations for its control (*viz.*, spraying with Bordeaux mixture) when systematically carried out are effective. This disease needs careful attention as it is apt, under climatic conditions favourable to the fungus, to do a considerable amount of damage.

Work on the various root diseases which attack coffee has been taken up by the Madras Government Mycologist and Mr. Anstead, but no definite conclusions have yet been reached. In the planting districts of South India, spraying with Bordeaux mixture as a preventive against leaf disease and black rot of coffee has been continued over small areas in several places, and it is fairly well established that the method is successful where it can be properly carried out. The limiting factors are labour and water. In Mysore the best spraying mixture tested up to date for black rot on coffee is the Bordeaux resin mixture. The department proposes to summarize and publish the results of its work on this disease at an early date.

Diseases of Rubber. The black thread disease continued to engage the attention of Mr. Dastur, First Assistant to the Imperial Mycologist. This disease is now in almost all rubber plantations in Burma. It is not confined to the tapping surface and the fruits, as previously supposed, but it attacks leaves as well and causes an extensive defoliation. The infected trees do not readily recover from the effects of leaf-fall, and consequently there is a great reduction in the yield of latex. The remedial measures previously suggested, *viz.*, removal of seeds and the free admission of light and air by thinning and pruning, have been tried on a plantation scale in Burma, and have proved effective in reducing both leaf-fall and

black thread on the tapping surface. But on account of the high cost of systematically removing the seeds. it is doubtful if this measure is commercially practicable. The application of Izal and other disinfectants such as Solignum and Brunolinum on the tapping cuts has not done much good, probably because these are washed off by the heavy showers of rain. It has been found that the extent of the damage done by black thread depends upon the depth of the tapping cut.

The fungus causing secondary leaf-fall of *Hevea* rubber in South India has been proved by Mr. McRae to be new and to differ from a somewhat similar fungus reported from Ceylon. It has been named *Phytophthora Meadii.* A Memoir on this fungus has been published (*Mem. Dept. Agric., India, Bot. Ser.*, vol. IX no. 5). The experiments on four 100 acre blocks for reducing this disease by removing the fruits and dead branches and ensuring protection of the tapped bark have given distinctly encouraging results. This treatment requires a large labour force for its successful application on planters' estates, but it has to be remembered that the disease causes a loss of 30 to 40 lb. of rubber, worth from £3 to £4 per acre per annum, and so if the cost of the operation leaves a margin of profit as it does in the present case, arrangements should be made as far as practicable to put it into force.

Miscellaneous. From the experiments made so far at Pusa it has been found that spraying chilli plants with one per cent. Burgundy mixture soon after the setting of flowers and again a fortnight later considerably checks the die-back disease both on the plants and the fruits. Spraying does not affect the quality of the fruits which on the other hand stand drying better and so command a better price. The disease can also be completely checked by sowing the crop a month later than usual. But in this case manuring at the rate of 2 cwt. of superphosphate and 1 cwt. of nitrate of soda is necessary, as otherwise the yield of the late sown crop will be poor.

Another disease of chillies causing blossom and twig rot and doing as much damage as the die-back was discovered during the year. This disease is due to a fungus *Choanephora cucurbitarum.* It has not been previously known to occur in India.

A further study of the *tikka* disease of groundnut at Ranchi has shown that the view that the disease is due to phosphatic depletion, suggested tentatively last year, must be abandoned. In this connection it is interesting to mention that the groundnut crop is attacked by two distinct fungi, one the cause of true *tikka*, *Cercospora personata;* the other an undescribed species of *Cercospora* which occurs commonly in the crop in various parts of India. The disease due to the unnamed *Cercospora* is apparently only known in India and in the last ten years has been noticed in various parts of this country.

Smut in *cholam* (*A. Sorghum*), *cumbu* (*Pennisetum typhoideum*) and Italian millet can be prevented by steeping the seed in a solution of copper sulphate, and as in previous years a campaign to popularize the use of this preventive measure was carried out in Bombay, Madras and Mysore.

As mentioned in last year's report, spraying operations against the leaf curl disease of peaches were continued at Taru, Peshawar. The difference between the sprayed and unsprayed orchards became very marked as the season advanced, and proved conclusively the advantage of spraying against this disease.

Among other mycological investigations at Pusa are the various diseases of apple trees in Kumaun, the sclerotial fungus attacking the Rangoon bean, the mildew (*Erysiphe Polygoni*) attacking opium poppy in Central India, wilt disease in *rahar* (*Cajanus indicus*) and root rot of the sál tree.

(*d*) Entomology.

It is proposed to review here the more important investigations carried on at Pusa and the successful operations carried out in the various provinces to control the outbreaks of insect pests. While appreciable progress continues to be made with the staff available, it may be said that it will take years to eradicate from the minds of the cultivators the idea that these pests come from the clouds or that they are a punishment from heaven. Inclusion of life-histories of the more important insect pests as lessons in the vernacular text books in use in primary schools is one of the means by which one can hope to familiarize the

rising generation of cultivators with the way in which these insects breed. The utility of practical demonstrations of the life-histories of common pests at shows and fairs and elsewhere where suitable opportunities are available is also self-evident. Above all we have got to instil into the minds of the ryots that these pests *can* be controlled and the damage which they annually cause to their crops can be minimized, provided only they bestir themselves and desire to learn how best to do it.

Cotton Pests. Cotton bollworms and their parasites are under special study at Pusa. It has been found that at the beginning of the cotton season, especially from July to the middle of October, *Earias fabia* and *Earias insulana* are the bollworms mostly present, but later on, from the middle of October to the end of January, the Pink Bollworm *Platyedra* (*Gelechia*) *gossypiella* is mostly present and damages the crop considerably. This later period covers the cotton picking season and it is then that *P. gossypiella* is at its worst. The bollworm parasite *Microbracon*—probably more than one species are concerned—which normally parasitizes *Earias* is also able to parasitize the larvæ of P. *gossypiella* whilst these are in the shoots and pods of the plant; but it seems to be unable to attack the larvæ once these have got into the cotton seeds. Large numbers of the larvæ in cotton seeds were collected and bred out in the quest for parasites but not a single parasite was reared from these. It is undoubtedly owing to the absence of control by natural parasites that *P. gossypiella* is so destructive in some parts of India, notably the United Provinces, and it seems likely that its control will be best effected by the discovery and introduction of an efficient natural parasite. This is not a problem which affects India only, the control of this pest being equally important to Egypt, the United States and practically all the cotton-growing tracts throughout the world. But *P. gossypiella* is apparently endemic in India, and it therefore seems possible that the required parasite, if such exists, is most likely to be found here. As in previous years the best trap-crop for bollworm larvæ was *Hibiscus abelmoschus*. At the beginning of the cotton season when *Earias* were increasing, the pods and shoots of *H. abelmoschus* were found at Pusa to contain a relatively larger number of parasitized bollworms than did

either cotton or any other trap-crop. The advantage, so far as incidence of insect pests is concerned, of sowing cotton intermixed with another crop was apparent as in the previous year, but the pigeon-pea (*Cajanus indicus*) is not a good crop to be intersown with cotton.

In the Punjab the parasite *Rhogas* (*Microbracon*) was successfully bred and distributed in cotton tracts. There were no bollworm complaints. This season also bollworm attack is below normal and parasites are present.

Three new parasites have been discovered on *Earias*: (1) a Tachnid fly on larvæ, (2) a brown Braconid, and (3) a black Chalcid on pupæ.

The stem weevil (*Pempheres*) which is a serious pest of Cambodia cotton has recently been reported in various places in Madura and Tinnevelly which were formerly free. Some work on this pest was carried out at Coimbatore by the Acting Government Entomologist. But the exact method in which infection is carried over from one season to another has not been ascertained, nor have successful preventive measures yet been discovered. It appears that the pest can be carried far afield with consignments of seeds.

Rice Pests. Stem-borers in rice were under observation at Pusa throughout the year. The insects concerned were: (1) *Schœnobius bipunctifer*, (2) *Chilo simplex*, (3) a second species of *Chilo*, as yet unidentified and apparently undescribed, and (4) *Sesamia inferens*. The last remained active throughout the year, whilst the other three species hibernated in the stubble. Observations made so far show that ploughing the stubble early in March kills a very large percentage of *Schœnobius* larvæ.

The swarming caterpillar (*Spodoptera mauritia*) which was doing serious damage to paddy was controlled in South Malabar by flooding the affected fields where possible, and hand-picking and hand-netting the caterpillars. The attack of the swarming caterpillar in North Travancore this year was not so violent, and it was completely checked by the kerosine oil process described in last year's report. There was a widespread attack of the beetle *Hispa* in paddy nurseries near Udipi in South Kanara, but it was successfully controlled by bagging the beetle.

In recent years crabs have come into prominence as pests of rice plants in the Indian Empire, and, although not strictly subjects for entomological investigation, some work has been done on them in their capacity as crop pests. They cut especially the young rice plants, and are reported to do damage in this way in Burma, Madras, some parts of the Bombay Presidency and also in some parts of Bihar. They are known to occur in rice fields in Western Bengal but not as doing any damage there.

There are more than one species of these crabs, and from observations made hitherto at Pusa it appears that they take three or four years to become full grown and capable of reproduction. In the hot weather they go deep down in the soil (11-13 ft. below the ground) and come out and resume activity in the rains. In Madras experiments with poisoned baits and the use of mechanical methods have shown good results in the case of fresh water crabs. In Burma the depredations of marine crabs are serious in the Thaton and other seaboard districts. The crabs migrate to the sea to spawn at transplanting time, and it is possible that the remedy will be to grow a later planted variety of paddy.

Sugarcane Pests. At Pusa considerable attention was again paid during the year to the cane-borers and to the question of the alternative wild foodplants of these pests. In the past, several different species of borers, all superficially much alike, were mixed up together under the name of moth-borer (*Chilo simplex*) which was supposed to attack sugarcane, *jowar*, maize and rice. In the last year's report it was mentioned that this moth borer had been differentiated into four distinct species. Further research during the year has revealed no less than ten forms distinguishable from one another by morphological differences in their larval and pupal stages, these differences as a rule being most easily appreciable in the pupæ.

A good deal of work was done during the year on borers and other insects occurring in the several species of wild *Saccharum* and other grasses occurring in the neighbourhood of Pusa. Besides *Diatræa venosata*, *D. auricilia*, *Sesamia inferens* and *S. uniformis* which are also found in sugarcane, nine

other borers not yet known to occur in cane have been found in these wild grasses. All these insects may be looked on as potential pests of cane.

Thick canes are more liable to attacks by borers than thin canes. The results of experiments made at Pusa show that the cutting and removal of all dead hearts and dry plants with insects found in them, which is the treatment usually recommended against borers in cane, retards the proper growth of canes to a great extent and is therefore useless.

In the last year's report mention was made of the suitability of lead arsenate solution as a dip for the protection of cane sets against termites. The results of trials made this year, however, showed no advantage in favour of those dipped in the lead arsenate solution. The liability of cane to damage by termites seems to depend largely on the nature of the soil in which it is grown. Generally speaking, the crop suffers much less when grown in clayey than in sandy soils.

Tea and Coffee Pests. The Entomologist to the Indian Tea Association continued his work on the problems connected with the tea mosquito (*Helopeltis theivora*), and also undertook the investigation of the action of the insecticides on red spider.

Sporadic attacks of the caterpillars of *Thosea cervina* and *Heterusia virescens* were reported on tea in South India. These are best controlled by handpicking of the caterpillars, and if noticed early in their career can be easily dealt with.

The coffee borer (*Xylotrechus quadripes*) is being controlled in Mysore by scrubbing twice during the period of emergence of the beetle. But as it is also necessary to destroy the more fully grown larvæ and such of the eggs laid in the interval between the scrubbings as have escaped the operation, experiments were made to find out a simpler remedy. Applications of Brunolinum, a crude distillate from coal tar, as late as two months after hatching, have been entirely successful. So far no injury to the trees as the result of its application has been noticed. With a view to keep down the quantity of the chemical required, applications were made only to the ridges round the stem by means of cotton wool soaked in this chemical, and these have also proved quite successful.

Experiments will now be made to see whether its application before the emergence of the beetle will kill the insect. The larva cuts a ring in the bark through which it appears possible the chemical may penetrate sufficiently to kill the pupa or the beetle.

Orchard and Garden Pests. In the Madras Presidency a spraying campaign was started against mango hoppers in the important mango tract of Alamanda in the Vizagapatam District. The results of the trials made in the Chittoor and Salem tracts in previous years were successful and the effectiveness of the method has been proved in many other places.

In Mysore, further investigation has resulted in the interesting discovery that temperature is one of the factors governing the multiplication of mango hoppers, and experiments have been planned to decide how far this discovery will prove of practical value. Spraying costs about Rs. 3 per tree for the season in Mysore and, as this is excessive, efforts are being made to find a simpler remedy.

In certain tracts of the Punjab *Monophlebus* is a serious pest on mango blossoms. Last season the following measures were tried at Shalamar gardens, Lahore, to prevent the bugs from ascending the trees and reaching the flowering shoots:— (1) Bands of well-carded cotton wool with fluffy side outwards and (2) grease bands were tied on the trunks. Both proved effective and insects could not cross them. Of the grease bands tried the crude vaseline and rape oil were best. It is proposed to make further trials next season.

In Bengal, it has been discovered that the mango weevil lays its egg when the fruit has attained half its natural size, the eggs being laid singly in small depressions on the surface of the fruit and covered over by a coating of a black substance giving the appearance of black spots. This discovery combined with evidence that the egg-laying period is confined to a week or two at the utmost ought to render remedial measures if not easy, at least practicable.

The utility of regular spraying of *Citrus* trees against *Euphalerus citri* was demonstrated at Sargodha. Three gardens were sprayed from March to June with crude oil emulsion and tobacco decoction. They are all bearing good fruit this

year. It is reported that the pest has got a thorough hold of all the gardens in the tract. People should therefore unite to eradicate it by regular spraying.

The entomological staff at Pusa paid special attention during the year to the pests of *Citrus* spp., jak, apple, pear, peach, nectarine, grape, guava, custard apple, and plantain. A large amount of information on Indian fruit pests has now been accumulated and will be published in due course.

Insect Pests of Stored Grain. Experiments were started at Pusa in 1915 to find out a successful method or methods of preserving grain in store against insect pests. These have now been concluded and an account of them will be written up for publication. The method of storage under a layer of sand gave the best results, the grains and pulses remaining perfectly safe and in good condition. Storing of wheat in granaries made entirely of straw so as to allow the grain to be exposed to the natural changes of climate did not give as good results as had been expected.

Tribolium castaneum which is essentially a pest of ground wheat (flour, *atta* and *suji*) and does great damage to these products has been definitely found to do no injury to sound wheat, but it breeds profusely in the dust produced in wheat already affected by *Calandra* and *Rhizopertha.*

Bruchus chinensis which is essentially a pest of stored pulse and to which it causes serious damage has also been found at Pusa to be capable of breeding in the field (in pods of cow-pea).

Sunning for seven days of pea seeds harvested from a crop known to be affected by *Bruchus affinis* has been found to considerably check the damage even when these seeds are stored for a year.

Lantana. Work on this weed pest was taken up in November, 1916, on instructions from Government and has for its object the collection of information regarding the occurrence within the Indian Empire of any insects which may be utilized as efficient checks on the growth of *Lantana.* With this object Mr. Y. Ramachandra Rao, Entomological Assistant in Madras, has been placed on special deputation under the Imperial Entomologist, and during the year under report worked in

Southern India, Burma and Assam. A very large number of insects have been found to occur on *Lantana*, but most of these appear to be merely casuals, not confined to *Lantana* but very polyphagous in their habits, or of no importance as checks on *Lantana*. This investigation is still in progress.

Protection of Wood against Termites. Simple experiments in the protection of wood against termites (so-called "white ants") have been in progress at Pusa since 1910, the termite utilized being *Microtermes obesi*. There are various species of termites and these have different habits and tastes, facts which are usually overlooked in carrying out similar experiments. Some kinds of timber may be more or less immune to attack by the local termites in one district, yet the same kinds of timber may be greedily attacked by other species of termites in another district. The experiments at Pusa have shown also that any particular method of treatment does not produce the same deterrent effect in all varieties of wood. The deterrent effect depends on (1) the treatment employed, (2) the variety of wood treated, and (3) the kind of termite against which protection is sought. Under conditions at Pusa it has been found that teak, sissoo (the red heart-wood), and jarrah naturally resist termite (*M. obesi*) attack without any treatment, and that, in the case of other woods subject to attack, treatment, whatever be the reagent used, in every case gives better results than no treatment. Wood can be rendered immune by impregnating it with (1) arsenicals or (2) creosote or wood-tar or some similar liquid, and the wood will remain immune as long as the arsenic is not dissolved out or as long as the smell of creosote, etc., is present. In actual practice treatment of wood with arsenicals is not easy without employment of a pressure apparatus, as it is difficult to get sufficient arsenic into the wood to preserve it for any length of time. Treatment with creosote, etc., however, is quite simple, as the desired results can be obtained by repeated paintings or by dipping in the preservative those parts of the timber which are to remain exposed to attack; although even in these cases, the use of a pressure apparatus to increase the amount of preservative taken up by the wood will considerably prolong the period of protection. For the ordinary person, however, who can only paint or dip wood-work likely to be attacked by termites,

the use of creosote will usually give the best results, especially for under-ground woodwork.

Miscellaneous. As in the previous years the Bihar and Orissa Department of Agriculture conducted, at Ghogha and Colgong, a campaign against *Agrotis ypsilon*, the greasy surface caterpillar which has been doing damage to cold weather crops by cutting the young seedlings at the base. Fifty-five Andres-Maire traps were used and a very large number of moths and caterpillars destroyed during the season.

No appreciable effect on the caterpillars was exercised by the removal of *Agra* (*Xanthium strumarium*), a wild foodplant of the pest at Ghogha.

At Mokameh where the *tal* lands suffer from the same pest, 100 bighas of land have been cleared of the weed *Cleome chilidonii* to see its effect on the *Agrotis* attack on the plot in the next season.

Our knowledge of the life-history of this pest has hitherto been incomplete. It is well known that as soon as the river Ganges drops and these flooded areas are cultivated and the crops begin to spring up, moths lay their eggs. It is not known whence these moths come. They are not found anywhere in the plains during April to August. With a view to elucidate this point the insect is being reared under artificial conditions at Pusa where caterpillars were observed on 3rd September, 1917, feeding in an experimental plot of tobacco on the farm. This shows that the insect is capable of breeding in the plains during the rains. But it is still uncertain whether the parents of these larvæ had bred in the plains or were early migrants from the hills.

In Mysore the campaign against *Amsacta albistriga* was organized, the affected villages having first been brought under the local Pests Act. The provisions of the regulations and the life-history of the pest were made known to the ryots of the villages concerned well in advance of the season by means of leaflets and circulars. A large poster illustrating the stages of the insect and the method of hand-picking was also distributed. There was accordingly little difficulty in organizing and carrying out the picking operations. Picking was also carried on at three other

centres. Nearly 12,000 moths representing nearly six million caterpillars were collected and destroyed.

In Travancore the coconut leaf-roller (*Nephantis serinopa*) attacked more than 5,000 coconut trees in and about Quilon in the course of a few months. Since the insect lives completely on the coconut leaf and passes through all its stages there, it is easily eradicated by cutting and burning the attacked leaves. As many as 3,800 trees were operated on and the pest brought gradually under control.

Various insecticides were tested at Pusa. Incosopol, a contact insecticide manufactured by the Indian Cotton Seed Oil Company, Navsari, gave satisfactory results on Aphids, scale-insects and mealy-bugs. Two grades of this insecticide were tested, of which that known as No. 2 gave much better results than did No. 1. Resin compound, fishoil-resin soap, and Incosopol No. 2 seem all about equally effective insecticides against Aphids, Aleyrodids, scale-insects and mealy-bugs, which are common garden pests: fishoil-resin soap and Incosopol No. 2 can be safely recommended as they cause no injury even to tender foliage.

Apart from field work life-histories were worked out in the Insectaries, especially at Pusa. Among those reared and studied at Pusa at least five new pests have come to light.

Useful Insects—Silkworms. Sericulture based on the mulberry tree or shrub is an important cottage industry in certain districts of Bengal and in Mysore. It also flourishes under State control in Kashmir and Jammu. Other forms of sericulture dependent upon the eri, tussar and muga silkworms are widespread in Assam, Chota Nagpur and parts of the Central Provinces. The Government of India, in 1915, appointed Professor Maxwell-Lefroy for one year to go into the whole question of the sericulture industry in India and he has submitted a voluminous report. The recommendations made by him are being considered by Local Governments and Administrations. Pending their decision, work in connection with this industry has been carried on on the same lines as last year.

At Pusa the work of crossing the races of mulberry silkworms has been continued with the object of producing a

superior fibre. The multivoltine mongrel races which have already been successfully established at Pusa continue to yield more and better silk than the indigenous multivoltine races. Eggs of some of these races have been distributed on a small scale to practically all silk centres throughout India for trial under local conditions there, and from all places except one satisfactory results are reported. The eggs of these races will be distributed on a large scale only when it has been proved to be certain that they will not degenerate later on. At present there are 20 different mongrel races under rearing at Pusa and the results are carefully recorded in each case. The work done by Mr. C. M. Hutchinson, Imperial Agricultural Bacteriologist, on the pebrine disease of silkworms and that done by the Entomological Section on the *tukra* disease of mulberry are detailed on pages 97 and 104, to which reference should be made.

In Bengal it is generally held that, if the pebrine disease of the silkworm can be successfully combated, the silk industry, at least so far as it concerns the production of silk cocoons, would still be economically sound. It is further agreed that with polyvoltine races the produce of disease-free worms will, even in the event of their contracting pebrine during their "education," succeed in spinning cocoons. As there appears to be little hope of the silkworm rearers in Bengal producing disease-free seed for themselves, the problem becomes one of producing a sufficient quantity of such seed for the industry. The department at present supplies only a small portion of the total requirements of seed for the mulberry districts in Bengal. A new type of organization will probably be required for the expansion of the work.

Hybridizing experiments are also being carried out in this province and the Berhampore Central Nursery is set apart for testing cross-bred races on a large scale. Some of these are apparently much superior to local *Nistari* races, but experience of their hardiness and immunity to disease is necessary before distributing any of them to silkworm rearers in the district. Work on the inheritance of characters in silkworms has been continued by Miss Cleghorn. Some of her cross-bred races are under trial at Berhampore. Mr. Hutchinson's revised method

of detecting pebrine in diseased moths was tried in the nurseries at Berhampore and Kurseong and found to be more accurate although more difficult in application.

In the Punjab, sericulture work was further expanded during the year and owing to the high price of silk the rearers realized good profits. The Director reports that the stage has now been reached when, if sericulture is to be established as a cottage industry in the province, a separate staff must be entertained. The crux of the problem lies in the provision of mulberry leaf, and in this very slow progress has at present been made. The rearer, who has hitherto enjoyed the right of taking leaves free of cost, is ordinarily a landless man. Neither the landowner nor the District Board is likely to put money into mulberries for the benefit of this rearer. If sericulture is to be a commercial proposition, there must be a margin of profit for the mulberry grower, and it remains to be seen whether the rearer will care to keep worms when he has to pay the economic price of the leaf.

In Madras this industry is important in Kollegal and is in need of help. The silk rearers there know that the local seed is bad and therefore purchase seed cocoons from the north, *i.e.*, Mysore, in the hope that the foreign seed may be better. Much of the seed previously sold by the department was used by the people for reeling and not for rearing. From the experience gained by the department so far, it appears that no real progress will be made until a well trained specialist is employed to run a fully equipped silk station at Kollegal. This view has been accepted by Government and attempts are now being made to obtain such a specialist.

There are 11 sericultural farms in the Mysore State, three of which have been developed into central farms and grainages. These did useful work in popularizing improved methods in rearing and in the distribution of disease-free seed. A large number of rearers got their seed examined microscopically. Univoltine worms obtained from Kashmir were very successfully reared on the Bababudan hills, the cocoons produced comparing very favourably with those obtained in Italy or France. The results of experiments conducted so far with multivoltine breeds

have shown that the Mysore race is quite good. A co-operative grainage under departmental supervision has been started at Siddlaghatta, a very important silk centre. At the request of the Government of Mysore, Mr. C. M. Hutchinson visited the State and inspected typical rearing establishments, both Government and private. Demonstrations were also given of his revised method of examination of moths, and suggestions made as to the best methods of securing adequate and reliable supplies of disease-free seed and of diminishing the amount of contaminative infection during rearing. These suggestions have been adopted by the Sericultural Department of the State.

In Travancore there appear to be good prospects of sericulture becoming a profitable cottage industry. The department maintains a silk farm. It has been found that the Pusa and Kashmir mulberries produce much better leaf than the variety locally cultivated. Pusa silkworm seed has been found to give the best results. The introduction of mulberry cultivation into the villages is being continued.

In Burma experiments are being made at the Saunders Weaving Institute, Amarapura. There is a flourishing mulberry garden at Lashio, and the Superintendent, Northern Shan States, is obtaining the services of a silk-reeling demonstrator from Pusa. Arrangements are also being made to get a demonstrator to teach the silk-breeders of Paukhaung in the Prome District.

The " Tukra " disease of mulberry, resulting in curling and malformation of the shoots and new leaves, has been known for a long time in Bengal, where it is sometimes bad, and a few affected plants have lately been found at Pusa also. An investigation of the cause of this disease was carried out at Pusa during the year, and it was found by experiment that the curling and subsequent malformation of the shoots was due to the presence of a mealy-bug (*Pseudococcus*), and that, although two species of *Pseudococcus* are to be met with on mulberry, it is only one of these (as yet unidentified) which causes *tukra*.

It has been found that the practice of removing the affected shoots and burying or burning them is not effective by itself, as the nymphs hide themselves in the crevices of the unexpanded leaf-buds on the plants, and, as soon as these leaves expand, they

in their turn become affected and the disease is continued. Removal of the affected shoots followed by thorough spraying with fishoil-resin soap will probably prove more effective.

Lac. The value of shellac exports during 1917 reached the unprecedented total of £2,314,000, a sum which gives this commodity a very respectable position in the list of India's exports. The total annual production of lac in this country excluding Burma may be reckoned at 120 million lb. If only a portion of this were treated according to the new method recommended by Mr. C. S. Misra, in his article on " The Present Condition of Lac Cultivation in the Plains of India " published in the *Agricultural Journal of India*, vol. XIII, pt. III, it would bring in some additional lakhs of rupees. Standardizing the product and popularizing it among the consumers of shellac which even in its standard form is more or less adulterated with foreign ingredients such as colophony and orpiment, will naturally take time, but it is presumed that as soon as consumers begin to appreciate the merits of the new product, they will restrict and gradually give up the use of the adulterated material—the shellac. Much work has still to be done on the manufacturing side, but the primary necessity seems to be the improvement of cultivation and placing it on sound and scientific lines. In view of the fact that lac is an article required in the manufacture of munitions of war, it is desirable that its cultivation should not be left wholly to cultivators who do not respond to the changes in market conditions and are not abreast of the times and persist in adopting wasteful and antiquated systems of cultivation. To this end, the terms of lease to the contractors may have to be so arranged as to secure them a steady yield and a fair profit. Efforts should be made to keep cultivators informed of the changed conditions of the market and its varying requirements so that they may adapt themselves accordingly. Demonstrations should be given of the advantage of adopting improved methods of cultivation and collection. They should also be advised against the pernicious practice of adulterating the natural product. Further, detailed and prolonged investigations require to be made into the subject of parasites and predators which do considerable damage to the crop. The development of lac cultivation on

proper lines is not only desirable from military considerations and from the fact that it is a source of some income to those aboriginal tribes which live on the outskirts of forests and are the first to suffer in times of famine or scarcity, but also because it is a valuable subsidiary industry for agriculturists in favoured localities.

(*e*) Pathological Entomology.

The work at present being done falls into the following four classes :—

(1) Observations on the life-histories and habits of blood-sucking and saprozoic insects.

(2) Experimental and practical work on mosquitos.

(3) Experimental work on insect psychology in relation to feeding and oviposition.

(4) Experimental and practical work on insect repellents and insecticides.

As regards blood-sucking and saprozoic insects attention was chiefly directed to the comparative study of the habits of the larvæ of Tabanidæ which show marked and interesting differences in the various species.

Observations on Pusa midges (genera *Culicoides* and *Ceratopogon*), a group of minute blood-sucking insects of which very little is known, are being continued in view of the possibility that these insects may convey disease.

As a result of the practical anti-mosquito campaign carried on at Pusa for the last three years, it has been found that its extension on trap-breeding lines is necessary. The main idea of trap-breeding is to supplement the ordinary (and almost inevitably incomplete) destruction of natural breeding places by supplying a large number of alternative breeding places of a suitable type which will absorb the local egg supply, but which are in one way or another kept under control so that none of the eggs laid in them shall reach maturity.

A certain number of organic compounds have been tested as larvicides and it has been found that xanthates have a very high toxicity for mosquito larvæ.

A long series of experiments has been carried out with the object of ascertaining the factors which influence mosquitos (especially *Stegomyia scutellaris*) in their choice of breeding places; and the deterrent or attractive effect of dilute solutions of a number of chemical substances as compared with pure water.

The results at present obtained indicate that (*i*) temperature has a definite influence, eggs being laid more freely in warm water, (*ii*) various chemical compounds have a deterrent effect when dissolved in small quantities (½ to 1 per cent.) in the water, (*iii*) a few chemical substances (especially sodium citrate and tartrate) have an attractive effect, a far larger number of eggs being laid in dilute solutions of these substances than in pure water.

Mr. Howlett has given much attention to the subject of repellents and insecticides during the last four years. Practical work in this connection was undertaken during the year in collaboration with Captain Pool, A. V. C., to discover a cheap repellent to effectively prevent Tabanidæ from attacking camels and so help to check the spread of surra among transport and other animals.

Among other important work of the section during the year may be mentioned the preparation by Mr. P. G. Patel, First Assistant to the Imperial Pathological Entomologist, of materials and coloured plates for a book on Indian cattle flies, and the contribution of a paper by Mr. S. K. Sen, the Second Assistant, on "Beginnings in Insect Physiology and their Economic Significance" to the Indian Science Congress at Lahore. This paper has been published in the *Agricultural Journal of India*, vol. XIII, pt. IV.

(*f*) Agricultural Bacteriology.

There are only two posts of Agricultural Bacteriologists in this country and both are located at Pusa. Mr. J. H. Walton, Supernumerary Agricultural Bacteriologist, remained on military duty during the whole of the year under report. Mr. C. M. Hutchinson, Imperial Agricultural Bacteriologist, had thus to manage single-handed the whole work of the laboratory. Important work was done on various problems connected

with soil biology, the bacterial fermentation of indigo in the steeping vat, the pebrine disease of silkworms and other bacteriological subjects.

(*i*) Soil Biology.

Nitrification. Further observations were made by the Imperial Agricultural Bacteriologist as to the conditions determining maximum nitrification in various types of Indian soils. Field observations of the seasonal variation and the effect of cropping and of fallow were continued. It was found that the presence of a crop, whilst diminishing the apparent amount of nitrification as measured by the nitrate found in the soil, actually increased the amount if it is assumed that the crop takes its nitrogen entirely as nitrate.

In connection with nitrification studies, further observations were made as to the formation of bacterio-toxins in soils, and a paper on this subject was read at the fifth session of the Indian Science Congress at Lahore.

Nitrogen Fixation. Experiments were continued by Mr. N. V. Joshi, First Assistant to the Imperial Agricultural Bacteriologist, upon the specific nature of various strains of *B. radicicola* and upon apparent symbiotic fixation of nitrogen without nodule formation in the case of inoculation with foreign strains. Clear evidence of stimulation of growth by non-symbiotic nitrogen fixation both by azotobacter and nodule organisms was obtained. These observations will form the subject of a paper now in course of preparation. In the Punjab experiments on nitrogen fixation have been continued and extended by Mr. Wilsdon, the Agricultural Chemist.

Green-manuring. The main and controlling factor in the decomposition of green manure is the incidence of rainfall following its burial. As this is frequently defective, a method of carrying out the initial stages of decomposition by rotting the crop in pits was devised by Mr. Hutchinson. The method is explained in *Pusa Bulletin* No. 63. The practicability of this method is being tested at Pusa and in the various provinces. The field trials arranged in collaboration with the

134317

Imperial Agriculturist were continued on the experimental area of the Pusa farm; the increased returns obtained on the *rabi* (winter) crop were considerable, but even these are not a measure of the practical value of this method which depends largely upon its sustained and residual effect. This has been well illustrated in the various crops on the experimental area of the Bacteriological Section, which have given consistent increases of some 30 to 60 per cent. not only over the unmanured but over plots receiving adequate applications of such manures as nitrate of soda and oilcake, over a period of three seasons including the year of application. The effect on Java indigo in the third year is especially marked.

At Coimbatore, the practice of pitting and rotting a green manure crop before applying it to the land has been found to give crops quite as good as those raised after green manure was ploughed into the puddle in the usual way. On the other hand, the new practice enables labour to be more economically used and so is cheaper. The Director reports that for these reasons this modified method of green-manuring will be adopted as part of the farm practice.

On the black soil of the Tharsa farm in the Central Provinces, however, *san* (*Crotalaria juncea*) rotted before being applied failed to give results of any value in the case of irrigated wheat. It may however be mentioned that the season was a most unfavourable one for wheat.

Phosphate Requirements of Soil Bacteria. Further work on this subject led to the following general conclusions :—

(1) Increase in available P_2O_5 greatly increases the general bacterial activity of a soil, and therewith the formation of CO_2; there is a positive relation between the amounts of CO_2 thus formed and the solubilization of phosphate in the soil, but this varies with the character of the latter.

(2) Addition of soluble phosphate increased the ammonification rate in all the soils examined.

(3) Addition of phosphate in many cases diminished the nitrification rate, apparently owing to the dis-

proportionate increase in non-nitrifying organisms. The final result over long periods of time in most cases showed no increase in the total nitrate formed.

(*ii*) INDIGO.

Experiments carried out in the Pusa factory in 1917 have confirmed the theory propounded by the Imperial Agricultural Bacteriologist in last year's report, that the yield of indigo in the process of manufacture depends in the first place upon the completeness of bacterial hydrolysis of the indican contained in the leaf; that this is determined by the presence or absence of sufficient numbers of specific bacteria; that variations in yield between individual factories probably depend mainly upon the character of the bacterial flora of the steeping vat, this being again determined by that of the water supply. So far as indigo manufacture is concerned, bacteria may be divided into three classes:

(1) Active hydrolyzers.
(2) Inert so far as indican is concerned.
(3) Active destroyers either of indican or indoxyl or both.

In order to attain maximum hydrolysis of the indican, it is necessary to arrange for (1) the removal of all deleterious bacteria from the water supply; (2) the use of artificial cultures of such quantity and vigour as to overwhelm the original population of undesirable bacteria.

It is a well known fact that bacterial numbers in water can be greatly reduced by settling and still more so by precipitation; mere storage in reservoirs also reduces them in quantity. Most factories use *khazanas* or reservoirs as settling tanks with a view to remove suspended mud which would contaminate the indigo. But in many cases the *khazana* is not large enough to supply water to all the vats in use at one time, so that a certain number of the latter are filled with water which has stood for several hours in the *khazana*, the remainder being watered by practically direct pumping from an outside source, whether river, lake or tank. This at once tends to create differences in

the bacterial content of the steeping vats, which may very well be of a sufficiently high order to produce variations in the fermentation going on in the latter. Such variations as also the number of bacteria would be reduced by the use of *khazanas* of adequate capacity, allowing of settling the whole amount of water used each day.

Apart from the bacteria present in the water, it is to be remembered that the plant itself introduces an enormous number into the steeping vat. But the bacteria generally associated with the plant do not seem to include as a rule any large number of deleterious organisms, and, even if there were, these bacteria will not have time to exercise much influence upon the character of the fermentation in the *khazana* water already successfully inoculated with the desirable species.

It appears probable from the past season's experience that, by sedimentation and the introduction of sufficient amounts of vigorous cultures of the proper species, it should be possible to alter the character of the fermentation in the steeping vat so as to secure more complete hydrolysis, but a considerable amount of work must be done before it is possible to elaborate a routine method suitable for use in a factory without immediate scientific control. The hot water extraction method has been tried at Pusa, and its use has resulted in eliminating undesirable bacteria and in securing not only a high percentage of extraction but complete hydrolysis and the production of good quality indigo. It is of course quite possible that its use on a factory scale may prove uneconomical in view of the fuel consumption involved, but engineers, whose opinion has been taken, do not consider that this is likely to be the case.

(*iii*) Pebrine.

It was mentioned in the report for 1915-16 that Mr. Hutchinson had undertaken an investigation of the conditions of incidence of the pebrine disease of silkworms in India, the primary object being to determine whether the failure to avoid disease in India by using the Pasteur method of selection of disease-free seed is due to any inherent inapplicability of the method to Indian conditions or to its improper use. It has

been found that the method as practised in Europe is not applicable to the conditions in this country, and Mr. Hutchinson has devised a new method which is an adaptation of the classical Pasteur method to local conditions. It was also emphasized in last year's report that the elimination of any undue percentage of hereditary infection by this method must be supplemented by the adoption of methods of rearing calculated to avoid subsequent infection. The principal, if not the only, means of infection other than by hereditary transmission is by ingestion of the spore form of the parasite with the food. Further work was done during the year with special reference to the mechanism of infection. Microtome preparations and dissection gave clear evidence of the rapid rate of development and spread of the parasite in the tissues of the host in this country as compared with that described by Pasteur. Thus artificial infection of a larva, by feeding only once with pebrine-infected food just before spinning, resulted in a heavily pebrinized moth, and in earlier-stage-larvæ similar treatment resulted in the presence of numerous actively dividing forms of the parasite in the epithelial cells of the gut of the host only three days after infection, as compared with a necessary interval of ten or fourteen days in France. Similarly in hereditary infection through the egg the epithelial cells of the gut of the embryo were found to be infected several days before oviposition. It is therefore clear that *Nosema bombycis* in India has attained parasitic activity of a high order which is liable to make the spread of the disease even more rapid than was the case in Europe in the middle of last century, when the silk industry was very nearly destroyed, and it is all the more necessary to adopt the strictest measures to prevent such an occurrence in this country. It seems probable that the climatic conditions which enhance the activity of the parasite have a compensating action in reducing the length of time during which the spores retain their infective power, and it may be that this factor has been the only one which has so far prevented the disease from wiping out the Indian silk industry altogether. It should be remembered, however, that this factor only affects the spread of the disease by contaminative infection, and does not at all reduce the hereditary transmission, which is certainly of equal importance.

The viability of pebrine spores was further tested, and the results of the experiments showed clearly that under moist conditions such spores rapidly lose vitality, whereas in dry air, even at high temperatures, their viability is retained for considerable periods of time.

The reliance which has been placed upon copper sulphate as an antiseptic for rearing houses was shown to be based on theory rather than observation, as 75 per cent. infection was obtained with pebrine spores treated with 1 per cent. copper sulphate solution, whereas 1 per cent. formalin secured complete immunity under similar conditions.

The Government of India have under consideration a proposal to appoint a proto-zoologist to complete the investigation initiated by the Imperial Agricultural Bacteriologist into the pebrine disease of silkworms, and also to study other diseases to which the various kinds of the silkworm are subject.

(*iv*) Miscellaneous.

In the Punjab some bacteriological work was done during the year by Mr. Wilsdon. This officer has completed preliminary experiments on the effect of varying concentration of nitrogenous materials on the rate of nitrification and these will be extended. He is also making experiments on the removal of impurities in water by treatment with alumino ferric followed by subsequent settlement of the precipitated impurities. Bacteriological examinations are being conducted at the same time at the Lyallpur Water Works in order to gauge the improvement produced in this respect. Experiments directed towards determining the most economical methods of applying sullage to agricultural land have been designed and tanks have been constructed at Lyallpur, but actual experiments with sullage have not yet been started as the land which has been placed at Mr. Wilsdon's disposal by the Lyallpur Municipality has not yet been sufficiently evened up by cropping.

In the Central Provinces experiments on sewage purification have been undertaken with a view to finding out how far sewage is modified and absorbed when applied to black cotton soil. Of the total nitrogen supplied to the soil as sewage, about 33 per

cent. was found to be in a soluble form in the drainage water of the cropped plot while from 43 to 49 per cent. was recovered in the drainage water of the fallow plot. The smaller amount of soluble nitrogen in the drainage water of a cropped plot is no doubt due to a larger proportion of the nitrate nitrogen having been used up by the crop. It would appear therefore that to use fallow land for the purification of sewage is a wasteful practice. Judged by the standards given by the various authors for purified sewage effluent the drainage water obtained in these experiments was found to be sufficiently pure.

The biological examination of the embanked wheat soil of Jubbulpur has not yet been completed, but the results obtained up to date indicate that cultivation done at the proper time during breaks in the rains stimulates nitrification and gives an increased outturn of wheat.

(*g*) Agricultural Engineering.

Agricultural engineering concerns itself principally with (1) devising and testing better and more efficient agricultural machinery, (2) providing water for irrigation in non-canal areas either by sinking new wells or by increasing the supplies in existing wells and putting up pumping installations where these can be worked profitably, and (3) power-driven machinery. This last is concerned with the reclamation of waste lands, the drainage of swampy ground and waterlogged soils, or with keeping down the level of saturation in canal-irrigated tracts; deep ploughing by means of steam and motor ploughs; power driven plants for crushing cane, grinding bonemeal, etc.

As regards the first set of problems, implements for tillage are of first class importance, and this is more especially the case in India where experiments conducted by Agricultural Departments have shown the great possibility of increasing the yield of crops by improved methods. It is almost certain that this will be brought about to a considerable extent by improved implements as the ryot has probably reached his limits with his present stock in trade. The demand in India for improved implements, which has arisen within the last decade or so, has

been created and fastered by the Agricultural Departments. Besides improved implements, there is ample scope in India, in spite of its vast rural population, for the introduction of labour-saving machinery such as reapers, winnowers, threshers, etc., especially in parts like the Punjab, Central India, Central Provinces, Bombay, etc., where cattle are not so numerous as before and agricultural labour, inefficient as it is compared with that in European countries, is getting dearer. The great thing is for the engineers to remember that in devising new implements they must keep clearly before them the fact that many of the present implements used by the ryots are the result of circumstances rather than lack of knowledge.

The question of pumping water from rivers, channels, water-courses and wells is a very important one to this country subject as it is to extensive and serious failures of the rains. There are large areas of land which border on rivers retaining an ample supply of water throughout the hottest weather, and such land can be effectually protected from drought by the installation of pumping machinery. A very noticeable example of the efficacy of this method is at Sukkur in Sind.

"There are at least 3 million wells in India from which water is lifted for irrigation and the number of men and cattle employed on this work is very large. The Indian Irrigation Commission of 1901-03 reported that the area under wells was not less than 16 million acres and went on to remark: 'It may not be sanguine to look forward to a period when the area under well irrigation throughout India will have been doubled.' Since this opinion was expressed, mechanical methods of lifting water from wells and rivers have been greatly developed and the depth from which water can now be profitably raised is at least twice what it was 15 years ago. This enormously increases the volume of underground water which can be tapped and consequently the area which might be brought under irrigation. Within the last few years fully 1,000 pumping stations have been established in the south of India and the number is large enough to warrant the conclusion that mechanical methods of lifting water for irrigation can be applied in India on a very extended scale."[1]

[1] *Report of the Indian Industrial Commission, p. 60.*

But it is necessary to emphasize that for such plants to pay they should be kept working for a large part of the year. This means that cultivation should be intensive. While the number of sites available for pumping is large, the sum total of the men who own such land, and have the will, means and energy to make use of their opportunities is small. It might be thought that a solution of the difficulty lies in an arrangement for an enterprising man or a company to put up the pumping machinery, work the engine and retail the irrigation water to the cultivators. But in some parts this is a very doubtful speculation for the man who puts up the machinery, as will be seen from the following extract from the report of the Bombay Director of Agriculture:

"This department tried the experiment at Nangaon (Poona District) and put up a large suction gas plant on the Bhima river. It has been run at a loss for the past 7 years and the water little used by the people. A man who tried the same thing on the Bhima river in the Ahmednagar District found the difficulties so great that he has kept the plant idle till the present year, when, in view of famine, we have galvanized him into activity. Another man who put up a first class pumping plant on the Sabarmati river near Ahmedabad found the cultivators so difficult to deal with that he cut his losses by removing the plant. Excluding this solution of the difficulty, we must realize that the men who are capable of developing such resources seldom own the land, while those who own the land susceptible of development seldom have the necessary enterprise, skill or means."

The work done during the year under the head of well-boring and pumping in the various provinces may now be briefly noticed. It may be mentioned at the outset that it is only in Bombay, Madras, the United Provinces and the Punjab that Agricultural Engineers form part of the departmental staff.

Owing to the dearth of machinery and engineering stocks of all kinds the year has been a difficult one for the agricultural engineer in more senses than one, and the public have generally regarded the present high cost of machinery as prohibitive and

have decided to wait for a more favourable time to launch out in this respect.

In the Bombay Presidency there are a large number of pumping plants in Gujarat. These, and the water supply which has been secured by boring in this tract during the last 10 years, will do much to relieve the present critical famine situation. In the Deccan there are 20 pumping plants which it is hoped to keep working satisfactorily. The department is also lending out all its experimental pumping machinery on easy terms to meet the famine difficulty.

The very high price of piping has checked demand for well-boring. Only 108 bores were made of which 64 were successful.

In Madras many pumping installations were obliged to stop work owing to fuel difficulties. During the year 27 new pumping installations were completed and 17 were under erection. Of these 44, only 8 comprised new machinery, the rest being second hand sets or additions to existing installations. The number of installations which paid the annual fee of Rs. 15 for periodical inspection of their plant was 128 as against 111 last year. This increase shows that more people are coming to appreciate the good value they obtain for this fee.

Thirteen test pumping sets, maintained by the department, were continuously hired to ryots for testing wells and for emptying wells under course of construction or deepening.

During the year the number of holes bored was 307, the total depth bored being 16,267 feet. The difficulty of obtaining steel pipes for lining borings compelled the department to employ most of their boring sets in the inland districts where the sub-soil is mainly hard rock in which lining pipes are not required. In the coast districts soft alluvial sub-soil makes the use of lining pipes imperative. Six artesian springs were struck in the Kistna, Chingleput and Madura districts.

The mapping of underground water supplies has now been completed in Chingleput, Tanjore, South Arcot, Vizagapatam and Godavari. Approximately 40 per cent. of the known borings in the alluvial tracts have been found to be connected with mean sea-level.

Twenty-seven experimental borings were made at the cost of the department to find the approximate depths of water-bearing sand in different districts of Bihar. For private persons and others in the province 54 borings were completed of which only 9 were unsuccessful. At Balasore, in the course of exploratory borings done for the Sanitary Department, artesian water was discovered in two cases.

In the United Provinces 8 tube wells were put down and work on a few more has been begun. A very large number of *pucca* wells in these provinces have their cylinders resting in sand. The supply of water in these can be enormously improved by the sinking of a strainer pipe in each. The Director reports that the type of well, known as the Chaudhri well, by which water is pumped direct from a pipe sunk through the clay foundation, is attracting attention owing to its cheapness of construction and convenience of use.

In the Punjab, 337 bores were sunk during the year. These were for augmenting the supply of water in ordinary wells. Soils which could not be explored two years ago by the ordinary methods of boring are now yielding a considerable water increase by the use of strainers at a very low cost. Three installations for drawing water by mechanical means from large tube wells were completed during the year. The average yield is approximately 30,000 gallons per hour, the cost of the three being Rs. 27,000. Two other installations are in progress. A small size motor-driven pump was installed at Lahore.

In Burma, a temporary Agricultural Engineer was appointed in May 1917 for one year with a view to determining whether there is scope for the permanent employment of such an officer in the present state of agriculture in the province. In this connection the Director writes as follows :—

"There can be no doubt whatever of the necessity for a wholetime permanent engineer to advise and assist cultivators as to machinery, small irrigation schemes, well boring, water lifts, improved implements, etc. The Burman is progressive and perfectly ready to use machinery but is often deterred by failures due to ignorance of how to run or repair it. Labour-saving machinery is specially necessary in a country which still has

large areas of waste land and a sparse but highly intelligent and go-ahead population. The appointment of an Agricultural Engineer is one of the first needs of the department after the war."

Turning to the side of work relating to the use of mechanical power for reclaiming waste land, draining swamps, etc., we may say that not much has yet been done in this respect but under the stress of war various types of motor tractors have come into use in England and America and are being perfected. The departments in India are keeping in touch with this work and it is hoped some of these can be adapted to Indian conditions.

The Director of Agriculture, Madras, reports that ryots in heavy cotton soils which are liable to be overrun with *hariali* (*Cynodon dactylon*) grass after a series of wet seasons will welcome mechanical ploughing if it is comparatively cheap and effective. The local department is going to try this year a motor tractor which it has rebuilt with a four cylinder motor engine. The purchase of another tractor has been sanctioned. The results will be awaited with interest as there is likely to be a big demand if a suitable tractor is found.

Steam ploughs continued to do good work in Bombay though the high cost of stores and the difficulty of obtaining coal added to the cost of ploughing in this way. As a result of five years' experience, the Agricultural Engineer, Bombay, finds that the total cost (including all charges) of ploughing an acre of heavy black soil in the Dharwar District to a depth of 16 inches is Rs. 28 and the people are prepared to pay this. It is notoriously an expensive thing to run a single set of steam ploughing tackle and the shortness of the ploughing season presents a financial difficulty. The experience gained indicates that it would be quite possible for a company owning several sets of steam ploughing tackle and operating from a centre (like Hubli) to work at a profit if the engines could find some work to do during the rains. By removing the front wheels and substituting a roller the engines could be converted into steam rollers and so find work throughout the year, provided that they could secure from the Public Works Department and the local municipalities contracts for road rolling. The Agricultural Engineer

has been asked to prepare a scheme for working a steam plough and steam roller company on such lines.

The substitution of mechanical for bullock power will lead to most substantial results in cane-crushing, and if India is to save her sugar industry the sooner she adopts it the better for her. Power-driven machinery for crushing bones and oil seeds will also enormously influence the progress of Indian agriculture by making available bonemeal and oilcakes for manurial purposes at somewhat cheaper rates, and it is to be hoped that expansion will take place on these lines in the country in the near future.

CHAPTER III.

PROGRESS IN DEMONSTRATION AND CO-OPERATION.

(*a*) Demonstration.

A large number of cultivators being illiterate, it is necessary for the Agricultural Department first to ascertain their needs and then to demonstrate in a simple way how they can most effectually be met.

So far the main improvements in Indian agriculture we can recommend are better implements, proper manuring and substitution of better varieties for the inferior ones at present grown by the cultivators. As agriculturists quickly seize what is carried to their mind through the channel of their eyes, the best way of convincing them is by ocular demonstration wherever this is feasible. Accordingly demonstration farms and demonstrations on cultivators' own fields or at exhibitions, shows and fairs are freely made use of. Another method for successfully raising the level of cultivation practice in backward tracts consists in establishing colonies of expert cultivators where practicable. Individual expert cultivators are also utilized to introduce improved methods in new districts, and this is probably the soundest method at present in use.

Knowledge of improved methods and the doings of the department is conveyed to cultivators through Agricultural Associations, vernacular agricultural journals, leaflets and circulars, the general vernacular press, and the preachings of itinerant assistants. With a view to make improved implements and manures available to cultivators, depôts are opened by the department. In some cases co-operative credit societies have taken up this line of work. For the provision of pure seed or seed of an improved variety of crops the department maintains seed farms and seed depôts. This line of work is being gradually made over to Agricultural Associations or Co-operative Agricultural Unions, the department only maintaining the purity of the variety on its own farms by exercising botanical control. In

some parts private seed farms are run by zamindars, Court of Wards estates and even groups of cultivators under the guidance of the department.

The success of demonstration work is a measure of the impression which the department has been able to produce on the cultivators as to its ability to teach them anything in their own job, and to do this it is absolutely essential to take into consideration the cultivators' capital, capabilities and conditions. The results produced on a Government demonstration farm are all too often productive of no result in the district because this primary consideration has been forgotten. But on the whole judged by this test the departments in India can be said to have achieved no small success. The time has now come when the obvious or more easily discovered improvements have been brought to the notice of cultivators in many parts of the country, and intensive scientific research will be required to turn out new improvements to place before them. For this the research side of the department particularly requires to be strengthened.

The demonstration work of the year has been marked by a reduction in the number of improved implements and in the quantity of manures sold This was due to the high prices of all iron materials and the difficulties of transport. In other branches solid progress was made.

Bombay. The demonstrations carried out by this department consist principally in the distribution of seed of improved cottons, popularizing improved implements, teaching better cultivation and manuring of sugarcane, improvements in general farming and the utilization of fodder to the best advantage and storing it against famine. As regards the distribution of seed, 1,29,000 lb. of *N. roseum* cotton seed were distributed in Khandesh and adjoining tracts. Working from the Jalgaon seed farm as a centre, the department distributes fresh seed each year to registered seed growers, and these in turn pass it on to Seed Unions. Seed of Surat No. 1A. cotton was distributed to villages in the neighbourhood of Surat farm and the department made the usual arrangement for ginning the cotton and marketing the lint. In the Southern Maratha Country working from the Dharwar farm as a centre, the department gives out the

seed of Dharwar No. 1 cotton to selected villages and cotton sale societies dispose of the produce. Several of the most prolific local varieties of wheat have been taken up by the cultivators on a considerable scale as the result of the department's efforts to popularize them. There are in all 21 seed societies in this presidency.

The work of introducing and popularizing superior implements was continued and extended to new tracts. In the charges of the Deputy Directors, Northern and Southern Divisions, Rs. 72,000 worth of implements were sold, and the hire obtained for the use of implements maintained at the various depôts was Rs. 3,300. There is also a large sale of implements at the farms supervised by the Professor of Agriculture and in a less degree in Sind and the Konkan. The department stocks approved implements (with spare parts) for sale and hire at the farms and depôts. As soon as the pioneer work in any locality is done the sales are left to private agencies. Besides departmental sales, Messrs. Kirloskar Brothers who manufacture iron ploughs and other implements do a considerable amount of business and have many agencies in the southern part of the Presidency. Individuals also deal direct with the manufacturers and with importers in Bombay. There are 10 implement societies apart from the many co-operative credit societies which stock improved implements for the use of their members.

Cane cultivators have largely taken up the improved methods advocated by the department. The Director reports that

"in the Poona and Sholapur districts the Manjri methods have now been adopted so widely that they are known to every one, and in other districts they are spreading rapidly. A great factor in popularizing these improvements has been the short course which is held for cultivators every year on the Manjri farm, and which is each year becoming more popular. I found a man in the Sholapur District who had attended this course and fully appreciated the opening for profits that exists. By the adoption of our methods he was economizing water to such an extent that he was growing 7 acres of cane on the water provided by one *mhot*, as against the 2½ acres of cane which the ordinary cultivator can grow with such a water supply."

Some 70 shows and demonstrations were held during the year, and the Divisional Superintendents and district staff did a large amount of propaganda work in the villages and arranged for the cultivation of demonstration plots in many places.

The total number of Agricultural Associations in the Presidency is 65. Some of them have considerable funds and do useful work, but generally it may be said that the work is of a spasmodic character and carried on by individuals rather than by the association in its corporate capacity.

Madras. The usual demonstrations on ryots' own lands of single planting of paddy, green-manuring, drill cultivation, use of artificials, *jaggery*-making, use of iron ploughs, etc., were carried out. Agricultural demonstrators also gave vernacular lectures to ryots in their villages regarding the improvements advised. Some 52,000 sugarcane sets were sold from the Anakapalle and Samalkota farms, and 114,000 to ryots in Chingelput, Chittoor and North and South Arcot on seed farm conditions. Experts in *jaggery*-making were sent from Coimbatore to demonstrate their methods to ryots in various places in the districts of North Arcot and South Canara. In the latter district, some progress was also made, in conjunction with the Co-operative Credit Department, towards freeing the subtenant cane growers from their obligations to the professional *jaggery*-makers. The use of an improved type of furnace and pan was successfully demonstrated to the ryots at Kumbum in the Kurnool District where there is fairly extensive cultivation of cane.

As regards supply of cotton seed, there was a brisk demand for the selected strain Nandyal No. 2 in the Kurnool District and the whole stock of the department was sold at 50 per cent. above market rates for country cotton seed. 42,552 lb. of the selected strains, Hagari No. 1 and Nandyal No. 2, were sold to ryots as seed and 29,300 lb. issued for next year's seed farms. In the Tinnevellies tract, of the total departmental stock of 269,141 lb. of seed available, 250,834 lb. were sold to ryots for sowing in the 1917-18 season and 17,923 lb. issued to seed farms. In addition to this, ryots belonging to Seed Unions obtained 453,907 lb. of the selected strains and sold it for seed. Further,

dealers of Company cotton offered their seed at much higher rates than those charged by the department and yet the seed was readily taken up. The number of Seed Unions rose from 6 to 12 during the year. The aim of the department is to establish some 20 to 25 of these Unions scattered uniformly over the cotton tract so that they may supply the bulk of each year's seed. The department is in measurable distance of completing this organization, and can in future cut down the area of its seed farms and still effectively control the seed supply by providing small quantities of fresh seed for the Union Seed Farms each year.

Over 33,000 lb. of Cambodia cotton seed were sold in the southern districts.

The practice of drilling introduced by the department in Tinnevelly District is spreading. The figures for the year under report are 19,173 acres drilled and 208 sets of drilling and inter-cultivating implements sold, as against 15,351 acres drilled and 111 sets sold last year. The improvement is making real headway because it is evident that a ryot does not buy a set of implements unless thoroughly convinced of its advantages.

As regards paddy, over 160,000 lb. of seed were sold from various farms. The demand for the seed of the selected *Samba* and *Ramgarudan Samba* is particularly great.

The practice of reducing the seed rate of paddy continued to spread in all districts and it has already gone beyond the capacity of the department to keep trace of it. How fast this improvement spreads will be evident from the fact that in the Bhavâni valley of the Coimbatore District the area planted at reduced rates rose to 11,000 acres from 4,600 last year.

Over 328 tons of fish manure and fish guano were sold during the year. There is also an increasing demand for oilcakes. Five tons of bonemeal were distributed from Anakapalle with good results, and a bone disintegrater has been set up on the farm to be worked by the pumping engine when not used for irrigation. This is intended mainly as a demonstration to ryots owning pumping installations as to how they can supply their own requirements of bonemeal.

Altogether 234,363 lb. seed of green manure crops were sold as compared with 166,457 lb. last year. The demand is so great that the department finds it difficult to arrange for the supply. Ryots are being induced to provide for their own supplies of seed and private merchants are taking up the business to an increasing extent. *Dhaincha* (*Sesbania aculeata*), *kolinji* (*Tephrosia purpurea*) and san-hemp are the crops recommended for green-manuring.

In spite of the steadily rising prices of all iron implements, some 77 light Monsoon iron ploughs and 18 other locally made implements were sold during the year. As usual a ploughing competition was held on the Central Farm at Coimbatore, the prize being a Monsoon plough. Three special demonstrations of drill implements and Monsoon ploughs were given at Koilpatti. Advantage was taken of the large exhibition held at Madras during the Christmas holidays, " Our Day " celebrations at Mayavaram, and a local exhibition at Hospet to demonstrate the work of the department with regard to various crops, fertilizers and the use of copper sulphate as a preventive of smut on *Andropogon Sorghum*.

Agricultural Associations do not seem to be doing much in the matter of spreading agricultural improvements though there are exceptions such as that at Kumbakonam. In Malabar six village Agricultural Associations are reported to be doing useful work.

Bengal. It has been decided that demonstration of new varieties such as those of rice, jute and sugarcane by plot experiment supervised by an officer of the department is unnecessary, and the practice has been discarded in favour of a wide distribution of seed. There is now scarcely a district in the province where the seed of departmentally selected varieties has not been distributed. The selected seeds consist of three varieties of paddy (*Indrasail, Nagra* and *Kataktara*) and two of jute (Kakya Bombai and Rajshahi Selection No. 26). The principle of a wide distribution of small quantities so as to form a nucleus seed supply in a large number of centres is being adopted in the case of these selected varieties. 164,000 lb. seed of *Indrasail* paddy was distributed in 1917 in bags of 10 lb. each in Dacca

and Mysensingh districts through *panchayats* on condition that cultivators should return the same quantity after harvest.

We quote the following from the Director's report :—

Although the success of the scheme will depend largely on the extent to which the produce of the 10 lb. bags is kept for seed, it is apparent that the preservation of even a comparatively small percentage will mean a big advance on anything possible through intensive rather than extensive methods of distribution. For example, 2000 maunds of seed paddy would produce anything from 150,000 to 180,000 maunds last year. If then only 20 per cent. of that amount were kept for further seeding it would suffice for 90,000 to 120,000 acres in Eastern Bengal. The actual acreage figures cannot, of course, be ascertained until later in the season. The growers however, have kept rigidly to their bargain regarding the return of seed to the department which received back the whole quantity supplied. Considering that the number of growers amounted to thousands, 100 per cent. return of seed is a remarkable figure. The programme for this year originally aimed at the distribution of a total of 6,000 maunds in most of the Northern and Eastern Bengal districts. This amount has had to be slightly reduced (to 5,300 maunds) owing to an unexpected demand from Bihar for 1,000 maunds (500 of which was supplied) and an overestimate by 200 maunds of our farm crops.

Eight thousand and two hundred pounds of Kakya Bombai jute were distributed in 1917 in Dacca and Mymensingh districts in small packets of $\frac{1}{4}$ lb. each which is the amount required to sow the seed area of an acre of jute. The seed was sown by all the cultivators who received it and over 90 per cent. of these people have kept enough for their requirements for the next season. This means that there was seed for nearly 30,000 acres of Kakya Bombai in these districts at the beginning of the present season. After the present year, if the scheme is equally successful elsewhere, the total yield of jute will begin to be appreciably affected.

Twenty-four thousand and six hundred pounds seed of the Rajshahi Selection No. 26 have been arranged for to meet the next year's demand for this variety in Western Bengal.

The method of plot demonstration has however been retained for such items as the use of manures, implements, etc. This work has met with some success in Western Bengal where the use of bonemeal, the growing of groundnuts, and *dhaincha*

(*Sesbania aculeata*) as a green manure are being systematically taken up. Demonstration in this tract is carried on with the assistance of District Agricultural Associations. In connection with the use of manures it is interesting to note that Government have recently decided to extend the scope of agricultural loans to the purchase of manures.

Bihar and Orissa. Demonstrations of tested agricultural improvements continued to be given on the cultivators' own lands by District Agricultural Inspectors with the help of Kamdars. The agricultural associations and co-operative societies in Patna, Bhagalpur and Orissa Circles rendered considerable assistance in the demonstration work of those areas. Some of the associations have been reconstituted with active members who are undertaking definite programmes of work recommended by the department. Several enterprising zamindars have placed their lands at the disposal of the Agricultural Department for demonstration purposes. Such private farms, of which there are six in the Orissa Circle, have materially helped the work of the department.

Among successful demonstrations may be mentioned those of *dhaincha* (*Sesbania aculeata*) as a green manure, superior varieties of sugarcanes, the improved process of *gur*-making, groundnut and castor cake as a manure for potatoes and sugarcane, besides the distribution of Pusa 12 wheat, *Indrasail* paddy and the Finlow variety of jute. The system of manuring paddy lands with *dhaincha* has met with considerable success in the Bhagalpur and Patna Circles. The demand for seed exceeded the supply and arrangements have been made with private growers for the next year's seed. The area under groundnuts is increasing in the Orissa Circle where it was introduced on a very small scale in 1916.

During the year under report 193,454 lb. seed of different varieties (excluding sugarcane sets) was sold to the public.

The introduction of the Mungo variety of sugarcane and demonstrations of the improved method of *gur*-making in shallow evaporating pans were continued in Puri and Sambalpur districts. In parts of the Orissa Circle the department distributed whole canes to the value of Rs. 1,500 on a loan

system to cultivators. Arrangements were also made for the disposal on cash payment of 236,800 cane cuttings to tenants and members of the Khurda Co-operative Central Bank.

Various manures amounting to 92,781 lb. were distributed during the year. Thirty-five improved implements such as Hindustan and Punjab ploughs, sugarcane mills, etc., were sold to the public. Ten agricultural and industrial exhibitions were held in different parts of the province, where the department exhibited improved seeds and implements and gave practical demonstrations. Two small shows of calves sired by Government bulls were held for the first time at Jehanabad and Gaya. It is hoped to extend and improve on results attained at these small shows which are only in their infancy.

United Provinces. To cope with the increasing demand for seed, fresh departmental seed depôts and stores were opened during the year. Besides supplying an exceptionally heavy demand for sugarcane sets the department sold 62,000 maunds of wheat (principally Pusa wheats), cotton, gram, early *arhar* and groundnut. Ten depôts have been opened with a view to bringing the manures (castor, *nim** and *mahua*† cake) within easy reach of the cultivators at the lowest wholesale prices. The sale of improved implements declined owing to restrictions of supplies and rising prices. This is to be regretted as numerous demonstrations of ploughs and cultivating implements carried out by the department are leading to a demand which should greatly expand if they could be obtained more cheaply. Some co-operative societies are helping the department in seed distribution. Court of Wards estates also maintain demonstration and seed farms. Private farms, especially those of the talukdars in Oudh, which now number 48, continue to do good work in growing new crops and providing seed for the tenants of the estates. Most of these farms are under the direct management of the landowners who evince a keen interest in their working. They are also most helpful to the department in supplying seed on a large scale for stocking the depôts.

Special demonstrations were arranged over a block of villages in the Cawnpore District with lever harrows on irri-

* *Melia Azadirachta.*

† *Bassia latifolia.*

gated wheat. With a larger staff the department hopes to specialize more in the direction of raising the standard of cultivation and improving exhausted soils as opposed to the introduction of selected varieties.

Punjab. The most important work in this province is in connection with the extension of American cotton and improved types of wheats and the spread of improved implements. The department sold over 874 tons seed of 4F American cotton this year, sufficient to sow 220,000 acres. Altogether 12 cotton auction sales were held departmentally and two private ones at which the department gave assistance in classification and arbitration. With a view to help the growers to realize full prices for their produce, Bombay cotton prices were posted at 18 markets. The total *kapas* sold in auction amounted to 4,392 tons, valued at roughly £150,000 sterling. This figure represents only 10 per cent. or less of the total crop. The starting of private auction sales is significant as it illustrates the fact that zamindars are beginning to realize the necessity of co-operation. The Co-operative Credit Department is now taking up the question of cotton sales and will ultimately, it is hoped, give valuable assistance so as to free the Agricultural Department of this work.

As the result of 6 years' demonstration of the advantage of sowing cotton in lines and intercultivating it, the practice has now been adopted on 12,000 acres.

District Boards, aided in initial outlay by grants from the wheat profits, are coming forward with proposals for demonstration farms, but on account of lack of agricultural assistants it was not possible to make any substantial progress. The same shortage of assistants also handicaps the department in its district work.

As regards wheat, over 680 tons seed of Punjab 11 was stored by the department. Seed is also stored by zamindars and sold either by them or with the help of the department. The demand for this seed is so great that zamindars also exchange without the department's instigation. A lakh and a half of rupees have been advanced for the purchase of seed for the coming season apart from what is stored by the people themselves.

Owing to restrictions on import of machinery and high prices, only 725 imported agricultural implements were sold during the year as against 1,863 last year. Besides these, 306 bar harrows manufactured at Lyallpur, 132 Lyallpur drills and 59 Lyallpur hoes were sold. The last are now being used with success on cotton and *toria* (*Brassica campestris*) though originally designed for wheat. Besides demonstrating improved agricultural implements at fairs, the Department gave them on short loans to the people themselves. In the Gurdaspur Circle about 614 implements were lent out in the year. Itinerating parties are also sent through the villages to work these implements with a view to popularize their use.

Burma. The agricultural stations, sub-stations and district farms are at present the only centres of demonstration of the cultivation of crops. It may be mentioned that district farms are intended to test improved varieties from the main stations for suitability to local conditions and to serve as depôts for seed and implements for the District Agriculturists, but they are not seed farms in the sense that they produce and distribute large quantities of seed. Such distribution is done from them cautiously, and as far as possible multiplication is done by private cultivators after the seed has been proved to be suitable for their particular localities. In the case of dry zone farms distribution of seed owing to lack of previous experimental work is not yet in full swing. The department not only issues seed of varieties tested on the farms but buys and distributes seed where the public would have difficulty in obtaining it otherwise. Such action has resulted in the expansion of wheat and *pebyugale* (white Burma beans) cultivation. In the distribution of seed the District Agriculturists fill a very useful part.

In the Southern Circle over 3,850 baskets (192,000 lb.) of selected strains of paddy were distributed from the departmental and district farms. Over 84,000 lb. of *pebyugale* was bought and issued in this Circle.

In the Northern Circle over 5,000 lb. of Ngasein paddy and 250 baskets (12,500 lb.) of other kinds were issued from the Mandalay Station. 15,580 lb. of cotton seed, 86,000 cane sets, 1,125 lb. of jute and small quantities of sessamum, wheat, onion and gram seeds were also distributed.

Owing to complaints from the districts of bad germination of distributed seed, an extensive series of germination trials were carried on for two seasons. These have shown that storing the grain in heaps on the floor is the most harmful to germination. If bags are allowed to lie on the floor for several months, a certain amount of grain in the bags germinates. It has also been found that with some varieties of paddy the germination capacity is sensibly lowered when machine-threshed. On the other hand some other varieties are scarcely affected. The use of the threshing machine for seed paddy will now be discontinued. As the seed is also liable to suffer damage from the sun and occasional showers during the transport from farms to villagers, the multiplication of seed farms and seed growers is advisable so that pure seed may be locally obtained and saved from long and risky journeys.

Implements worth Rs. 4,200 were sold during the year. Cyprus ploughs seem to be fairly popular. Agricultural and cattle shows were held at two places where the use of improved implements, etc., was demonstrated.

The department is training a jailor to take charge of a farm for juvenile prisoners at Meiktila which has recently been sanctioned. A Kachin was trained as a demonstrator to work in the Kachin hills where it is hoped to raise potatoes, maize, sugarcane and vegetables. An expert cultivator from Bengal has been obtained to demonstrate jute growing in the province.

Co-operative Societies which are so successful in this province will be able to give material help to the Agricultural Department in its propaganda and district work.

Central Provinces. The demonstration work in these provinces is greatly helped by Agricultural Associations of which there is one in almost every taluk in the Southern and Western Circles, by private seed farms for rice, cotton and wheat, which are more numerous here than elsewhere, and among other things by the holding of divisional agricultural conferences and shows at which the officers of the Revenue and Agricultural Departments and a large number of Malguzars and influential cultivators meet together. The scope for demonstration in parts of this backward province is also great. Much useful work has been done in popularizing the use of san-

hemp as a green manure for paddy, oilcake for sugarcane, the Poona method of *gur*-making which is a great improvement over the local method, sale of improved implements, and teaching cultivators the use of irrigation water for crops grown in the areas commanded by Government tanks. The method of transplanting single seedlings of rice is being pushed in districts where either broadcasting or transplanting in bunches is the rule.

In the Nagpur District, over 26,000 acres were transplanted with single seedlings. Over 185 tons seed of G. 19, a selected strain of *gurmatia* rice, raised on private seed farms, was distributed in Bhandara and Balaghat districts. Over 22 tons seed of Pusa 12 and Sukerhai Pissi wheats was distributed during the year and forty sugarcane mills and 44 improved ploughs were sold.

In the Chhattisgarh Division the area under transplanted rice rose to 41,824 acres. The demand for seed of improved strains of rice and wheat is unlimited. Selected strains of rice were propagated on 57 private seed farms from which over 368 tons of seed were distributed to cultivators. The use of san hemp as a green manure for paddy was demonstrated in 45 villages. This hemp can be grown on land reserved for *rabi* cultivation and carted to the fields when required. Over 45 tons of wheat are being distributed for seed this season. Twenty-four iron cane mills, 27 *gur* pans, 54 ploughs and 10 winnowing machines were sold in this division. Successful demonstrations were given in the growing of good crops of groundnut, sugarcane, cotton and other crops on *bhata* soil hitherto considered barren.

In the Western Circle in which the principal staple crops are cotton and *jowar* (*A Sorghum*), progress continued to be made in organizing Taluk Associations which now number 28. Many of the members are propagating *roseum* and *buri* cottons, *jowar* and groundnut seed for distribution. A few of these associations stock implements for sale and demonstrate the use of them in the taluks. Some members belong to Co-operative Seed Unions which now number 31; while others run their own seed farms on individualistic lines. The programme of work

undertaken by these associations includes the running of 555 seed farms for the production of *roseum*, 50 for *buri* cotton and 126 for selected varieties of *jowar*.

Over 483 tons of *roseum* and 2 tons of *buri* cotton seed, 26½ tons of groundnut seed of the earlier and more easily harvested small Japanese variety, 12¼ tons of selected *jowar* seed and 9½ tons of castor seed were distributed. Two hundred and sixty-six ploughs were supplied from depôts supervised by the department. Many cultivators obtained ploughs direct from Messrs. Kirloskar Brothers. The use of cheaper linseed cake instead of clean cotton seed as a cattle feed was advocated and about 3,000 tons of this cake were sold by the local oil mills. Agricultural Associations are popularizing its use.

In the Northern Circle the number of certified wheat seed farms rose from 66 to 113. The demand for seed from these farms was as usual much in excess of the supply. Several additional private wheat seed farms are being opened and large Government seed and demonstration farms are being started in Damoh, Saugor and Seoni. In a year or two each district would be nearly self-supporting as regards its supply of improved seeds and implements. Improved varieties of wheat, sugarcane and rice are being introduced. Implements of the total value of Rs. 16,326 were sold in this circle during the year under report. The department intends in the coming year to increase the number of Tahsil Agricultural Associations in this Circle.

Assam. The principal demonstrations carried out by the department in this province are with bonemeal on paddy lands, the introduction of the *Indrasail* and *Georgesail* varieties of paddy and of Kakya Bombai jute, the introduction of potato cultivation in new localities and the substitution of the Shillong variety for the inferior local varieties where they are already grown, and the distribution of tested superior varieties of cane from the Jorhat farm, together with the popularization of the three roller iron sugarcane mills.

There are 34 honorary correspondents in the province. These men perform the same functions as Agricultural Associations in other provinces. The demand for sets of superior varieties of sugarcane was very great during the year and as

many as 4,57,100 sets were issued. The seed depôt at Gauhati supplied 11 tons of Shillong seed potatoes and 42 maunds of paddy seed besides cane sets. Altogether 13 sugarcane mills, 33 Meston ploughs and a few other agricultural implements were sold during the year. A second depôt is to be opened at Sylhet. The bone grinding installation at the Upper Shillong farm crushed some 6·32 tons of bones which yielded about 5·67 tons of bonemeal. In the Khasi Hills 45¾ tons of bonemeal were sold during the year. The Kakya Bombai variety of jute was successfully demonstrated in Sylhet and Kamrup and arrangements were made for the supply of seed of this variety.

In the Naga and Lushai hills the angami system of terraced cultivation of wet rice is being pushed.

As the result of demonstrations 215 improved manure pits were constructed during the year.

North-West Frontier Province. In this province the principal farm is at Tarnab. Besides this, there is a small station at Haripur. The work which the department began just eight years ago is gradually extending to all parts of the province. In the opinion of Mr. Robertson Brown the time has come when each district could with advantage have a small farm of its own. Without such farms which serve as district headquarters for the assistants, the work of this class of official tends to degenerate into aimless and unprofitable touring. The agriculturists of the province are but little influenced by conversations with members of the department, but, on the other hand, many are at once roused to enthusiasm when they see a good field crop or a fine pair of bullocks, a successful implement or a really good orchard, and it is in such cases that a little demonstration is worth a lot of preaching. Efforts are made at Tarnab to produce high yields on the demonstration areas and also to convince the agriculturists who visit the station in large numbers that the high yields produced on the farm are more profitable than the smaller outturns harvested in their vicinity.

Mysore. Considerable progress has been made in the popularization and distribution of improved agricultural implements, the improvement and development of sugarcane cultivation and the introduction of improved strains of *ragi* (*Eleusine*

coracana) of which a quantity sufficient to sow 1,000 acres has been distributed.

Over 700 tons of oilcake were sold for sugarcane. Red Mauritius cane which gives an increased yield of 10 to 25 per cent. per acre has been introduced into all districts of the Eastern Division of Mysore and over 8 lakhs sets were distributed. It is reported that increasing help is being received from the agriculturists of the State, some of whom have grown sugarcane and selected strains of *ragi* under the department's direction and turned over their produce to the department for distribution.

Fairly large quantities of seed of selected paddies, cotton, early maturing varieties of groundnut, *jowar*, and the Poona variety of turmeric were distributed.

The practice of transplanting in preference to broadcasting and the substitution of transplanting in singles instead of in bunches is being pushed. The growth of green manure crops for paddy, sugarcane, potatoes and areca and coconut palms is being largely taken up.

Over 1,600 ploughs and 36 sugarcane mills were sold during the year. The sale of implements on the hire purchase system which was started in January 1916 is becoming popular.

The co-operation of District Committees, Taluk Progress Committees, and Co-operative Societies was enlisted in the work of spreading improvements.

Travancore. Two demonstration farms and three experiment stations which also serve the purposes of demonstration are maintained by the department. The area under single seedling transplantation of paddy increased from 10,000 to more than 15,000 acres. The method of planting 2 to 3 seedlings as against the usual practice of planting 8 to 10 seedlings has spread so rapidly all over the State that it is difficult to estimate the area so planted. The department is demonstrating that paddy can be cultivated every year in *punja** lands which are at present left fallow every alternate year. Manures for paddy

* Lands which remain submerged under water from June onwards and which are cultivated with an early variety of paddy in November after bailing out water from the fields.

and coconuts (oilcakes, bonemeal, special paddy fertilizer, superphosphate, fish refuse, etc.), worth Rs. 14,000 were sold from the manure depôt maintained by the department. Besides this, the ryots purchased direct to the value of about Rs. 35,000. Some 2,000 lb. of improved paddy seeds were sold from the paddy farm at Nagercoil. With a view to multiply the seed of paddy varieties improved by selection, four Seed Unions have been formed. An exotic prolific variety known as Banku paddy has also been introduced.

The department by opening a farm in the sandy wastes along the coast has shown the possibility of raising a successful coconut crop on such lands by the adoption of scientific methods of cultivation. Over 500 acres have been planted by the cultivators in these tracts.

Some 5,000 sets of Red Mauritius cane were distributed, the Poona method of *jaggery*-making was demonstrated and the use of manures popularized. The cultivation of the two crops—groundnut and guinea grass—introduced by the department is spreading.

Five hundred pounds cotton seed was distributed to ryots in North Travancore for experimental cultivation. Twenty-seven Meston ploughs and 20 spare shares were sold during the year.

Baroda. Each of the four districts of this State has an Agricultural Inspector for educative and propaganda work. These officers demonstrated to the cultivators the use of improved implements and agricultural practices. They also secured orders for improved ploughs, sickles and cane crushers and distributed over 20,000 lb. pure seed of cotton, groundnut, indigo, lucerne and san-hemp. The temporary appointment of a Kamdar for pushing the cultivation of irrigated crops in some suitable localities has met with a fair measure of success. While no increase is reported in the number of District and Taluk Agricultural Associations, some progress has been made in the formation of Village Groups Associations consisting of members each of whom undertakes to do a definite piece of work.

(*b*) Co-operation.

The perusal of some of the Reports on the Working of the Co-operative Societies in the provinces for 1917-18 cannot but give the careful reader food for reflection, and a detailed analysis of the records contained therein is even more disturbing. In all too many cases the reports show clearly that it has become necessary to cry halt in the furious inter-provincial race which has been in progress for the last few years and to take vigorous steps to put the house in order. Too much attention in the past has been paid to increasing the number of societies, the thousands of members and the lakhs of working capital; and increase has been piled upon increase until a huge edifice has been created which is now showing unmistakeable signs of collapse in many places owing to the materials being defective. Societies which are "un-co-operative" to call them nothing stronger, bulk all too large in the returns. Arrears form too heavy a percentage of the outstandings of central banks, and such a bad condition of things exists in some cases that it seems as if the essential laws of banking were either unknown or deliberately disregarded. As a panacea we are told, "Legislation for swift and effective liquidation of societies is urgently required," but unless other and healthy societies spring up to take their place it is difficult to see where this will help the co-operative movement. In short, in some places the conditions in existence demand drastic measures, and the total elimination, from the records of such reports, of every society and its members which cannot truthfully claim to be co-operative, *is the first thing to be done.* This will enable the movement to appear in its true light, and real progress and growth, however small, will not be hidden away amidst the rotten wood which the tree is still allowed to carry. It is not much use informing the public that a province has so many thousand co-operative societies with so many thousand members, if on further examination it appears that a goodly portion of the societies and the members have absolutely no real right to figure in any list of Co-operative Societies, and that in many cases they are simply a standing illustration of what not to do so far as co-operation is con-

cerned. The whole situation requires to be taken stock of and the energies of the department concentrated on consolidating the present position before any further advance is made. Otherwise any such expansion is likely to result in a further crop of rotten wood in the near future.

That co-operation has a great future before it is admitted by all, but it is only by steady progress on thoroughly sound lines that it can achieve its ends, and the founding of unlimited societies which promptly proceed to conduct their financial operations with that "abandon" peculiar to persons who only arrange for a loan and not for the repayment, is not calculated to either popularize the movement or to conduce to that feeling of relief and confidence among the community which true co-operation should engender.

It was fortunate for India in a way that the co-operative movement was started a little in advance of the reconstituted Agricultural Departments. While agricultural credit societies were being firmly established and the members were imbibing the principles of co-operation, the Agricultural Department was feeling its way, gaining the knowledge of local conditions and gathering results of such experiments as after thorough testing could safely be placed before Co-operative Societies for adoption by their members. The two departments are now working in close touch and have joined forces to obtain the best results. This union is necessary in the case of the Co-operative Department to enable co-operation to rise to the height of its great task of raising the economic status of the people. On the other hand the Agricultural Department would, unaided, have made slow and halting progress.

The best will in the world cannot do much unless the financial side of the question has been studied. There is an old saying that "every one would farm well if he could afford to," but in cases where a man makes a scanty living solely from his land he will obviously never be able to invest any money in improvements until his income improves and he has the money to spare. Once the money is forthcoming the improvement can be started, but until it is made available all the exhortations and examples in the world must fall flat not because they are unappreciated

but because they are totally impracticable without the necessary available capital.

Agriculture in India has been since the beginning probably the most under-capitalized industry in existence and to this directly can be traced its backwardness. With his limited capital and implements the average ryot does as well as anyone could under similar circumstances, and, therefore, in most cases it is the circumstances and not the individual which require first attention and it is here that the opening for co-operation and its abundant benefits is clearly shown.

The primary object of the Agricultural Department is to improve the agriculture of the country and thus enable the cultivator to produce larger or more profitable crops. There are many different ways in which this object can be achieved. The supply of improved seed is one of them and here Co-operative Seed Unions and Societies are doing most valuable work. There are also other directions in which co-operation supplements the work of the Agricultural Department. For instance, it is not always enough to teach the agriculturist the use of new or improved implements or the value of manures for his land; it is necessary to help him to get what is wanted as cheaply as possible. Again it is very important to help the cultivator to get the best price for his produce. Co-operative Societies for the joint purchase of agricultural requirements and for joint sale of their members' produce are coming into prominence and are thus fulfilling a useful purpose in raising the economic condition of the cultivators. There is a wide scope for the application of the principles of co-operation in the case of dairying both as regards joint production of milk and its distribution. Co-operative Societies for the insurance of cattle are also capable of doing much good in this country by teaching their members to take better care of their cattle and insisting upon segregation and disinfection and immediate reporting of the outbreak of an epidemic to the authorities so that prompt measures can be taken for the inoculation of cattle and the localization of the attack. No doubt it is not everywhere that such societies can be started under present conditions, but a few successful

societies would demonstrate its advantages far more effectively than any amount of lecturing could.

We will now proceed to review the work of this department province by province. In view of the fact that credit societies make better farming possible by supplying their members with capital at cheap rates and are in other ways helping the Agricultural Department in its propaganda for the adoption of improved methods and practices, it is proposed first to notice briefly the growth of the credit side and then to turn to the development on the non-credit side of the movement.

Bombay. The total number of Agricultural Societies (including both credit and non-credit) rose from 1,091 to 1,390 during the year and the number of members from 80,762 to 101,333. The amount of working capital increased from Rs. 52·14 lakhs to Rs. 71·99 lakhs during the year. It is particularly satisfactory to note that the working capital is increasing more rapidly than the number of members. The average sum available per head has risen from Rs. 65 to 71. It may be mentioned that, outside Sind, all agricultural credit societies in this Presidency have been formed on the Raiffeisen model. In Sind the Luzzatti model is being introduced which combines shares with unlimited liability—a risk which is open to objection as among men of small education it is frequently not clearly understood. An examination of the objects for which loans have been issued shows that a large portion of the working capital goes out for current agricultural requirements. Members are learning to hold up their stocks on a rising market and loans for this object are also being issued. So long as it is done in moderation, this is not objectionable; but with the spread of co-operation this teaching may come home to roost in the same way as the original methods of co-operation—strikes—have become fashionable all over the world with such marked effect and inconvenience to the world in general. In some places members also buy the produce in the fields and earn a small middleman's profit by bulking and selling it at the nearest bazar town.

As regards agricultural non-credit societies, in most places experience shows that where it is proposed to start some type of non credit society, it is best first to form a local credit society

in order to familiarize people with the ideas of co-operation and then to build up the more advanced organization upon it. These societies require more care and attention and are at present being organized by an official staff. Societies for the sale of *jaggery* or other agricultural produce experienced the greatest possible difficulty in disposing of their stocks during the year owing to difficulties of railway transport. These difficulties also seriously interfered with the work of manure societies. There are 21 Manure Purchase Societies in the Presidency and the progress achieved has been very satisfactory. Castor, groundnut and safflower cake have become most popular. The total quantity of manure purchased was 8,348,176 lb. Local credit societies finance their members so that they can pay cash for their purchases, and in this way the manure societies secure a rapid turn over and carry on a comparatively large business on a very modest working capital.

There are 8 Cotton Sale Societies and they did fairly good work during the year. The Agricultural Department entrusted to them again the auction sales of Kumpta selections, and Broach and Cambodia cottons. There are 11 other sale societies for various products. The depôts for the sale of *jaggery* and the supply of cake manure to the members of the co-operative societies of sugarcane growers on the Nira and Godavari canals have been working very successfully. The chief benefits derived from sale societies are honest weighments, fair prices fixed by open competition among the dealers at an auction and no improper cesses or commissions.

Eight Seed Societies were started last year in Khandesh with the object of obtaining *roseum* cotton from the Government farms, growing it through the agency of registered growers as in Berar and distributing the seed so produced in the second generation to their members. These societies are a necessary correlative to the sale societies. Apart from these seed producing societies, many credit societies are willing to take up the distribution of selected seed grown by or under the supervision of the Agricultural Department. Some are already doing this but the stock of improved seed is not yet sufficient in most places to meet the demand. The foremost seed society is at Gadag.

There are 10 societies for machinery and implements. They purchase improved implements, oil engines and cane crushers, etc., and let them out on hire. Besides these, a few societies managed depôts either on behalf of the Agricultural Department or independently for sale of implements.

Ten Cattle-breeding Societies have been established and are proving very fairly successful. The aim of these societies is to gather a herd of about 60 good cows, to obtain a separate grazing area and to own a breeding bull. The cows are taken out daily from their different homes accompanied by the bull to the pasture, other bulls are kept off, all coverings are noted and a herd-book is maintained. This type of society promises to be quite popular, but as it is expensive and difficult to get good bulls and as it is necessary to secure separate grazing areas, societies of this type can only be started in those villages where good grazing facilities are available.

Madras. There was a net increase of 366 in the number of Agricultural Credit Societies during the year, the total of such societies being 2,271 on the 30th June, 1918. The total working capital of these societies rose from Rs. 88·03 lakhs to Rs. 97·93 lakhs. There is a gratifying increase in the loans for productive purposes and the Registrar reports that societies have been advised to encourage this type of loan, especially the financing of cultivation, the payment of *kist* and the holding up of the produce with a view to obtain favourable market rates.

A conference of the gazetted officers of the Agricultural and Co-operative Departments was held at Coimbatore in July, 1917, at which the lines on which the two departments could work more closely together in future were discussed. The following points were emphasized :—

(*a*) That in the past one department had often exploited a tract which the other department could not take up for want of staff and *vice versâ*, and that in future special efforts should be made to concentrate in the same tracts.

(*b*) That in many tracts the progress of agricultural improvement was hampered by the poverty of the

non-occupancy sub-tenants who were the real cultivators of the soil and that the Co-operative Department had not yet made much progress with supplying cheap credit to this class, although this was the essential first step towards improving their agriculture.

The general lines on which co-operative societies could take up non-credit work of the nature of joint purchase of seed, manures, implements, etc., and joint sale of agricultural produce were laid down; and the methods in which the officers of these two departments should co-operate for this work were formulated. As a result of this, some progress was made during the year, and considerable experience gained.

There are now 17 Co-operative Purchase Societies and two Societies for Production and Sale. The business done by these sccieties consisted almost entirely in the joint purchase of the requirements of their members. Their dealings were not on a large scale and the articles purchased were chiefly agricultural implements, seeds and manures. Similar activities were also successfully attempted by 24 ordinary credit societies and 4 local Unions. Only a few societies sold the produce of their members jointly. The most successful operations were the joint sale of paddy worth Rs. 2,375 by the Hindupur-Narasapur Society and the joint sale of chillies worth Rs. 1,750 by the Suravaram-Annavaram Society in Godavari and good profits were realized. The Kukkudakhandi Society in the Ganjam District also sold Rs. 3,000 worth of paddy. The Ketti Union made a joint sale of the potatoes produced by the Badaga Societies on the Nilgiris to contractors and obtained very good prices.

The Tanjore District Co-operative Manure Society at Nidamangalam shows great promise and should in time form the centre of manure distribution to the co-operative societies in the district. They manufacture bonemeal and flour-phosphate and supply the manure to the members at a rate far below that current. This society has admitted a number of Primary Societies as members and supplied during the year a large quantity of maure (fish manure and oilcakes) and seeds (cotton seed for cattle food and seed paddy) to ten of them. In South Arcot

the Rettanai Co-operative Agricultural Society did useful work in connection with the distribution of good seed of Cambodia cotton and groundnuts and the purchase of manures and implements. Most of the purchase of seed and manure was done under the advice of the Agricultural Department, and the Registrar thinks there is good reason to hope that societies may in future become useful channels for the diffusion of improved methods of agriculture.

Bengal. The number of Agricultural Societies rose from 2,857 to 3,374, membership from 110,961 to 125,590 and the working capital from Rs. 67,06,628 to Rs. 80,50,717 during the year.

There are 12 societies with limited liability for co-operative purchase and sale. Of these the Backergunge Sunderbans Co-operative Supply and Agricultural Sale Society is doing excellent work. The Dewangung Supply Society in Mymensingh is also reported to be doing good work.

There are 5 societies for production, and production and sale. Of these, the Naogaon Ganja Cultivators' Co-operative Society was started in July 1917 to eliminate the middleman's profits. Government have granted to this society the monopoly of trading in *ganja* and *bhang*. The membership of this society stood at 2,601 and working capital at Rs. 246,900 at the end of the year under review. It made a handsome profit during the year.

As regards co-operation and agriculture, the Registrar reports that real collaboration between the departments is on the increase and the lines on which they can best help each other are becoming more clear. Meetings between the district staff of each department and joint tours of officers are a feature of the year in many districts. Many societies obtained seed through the Agricultural Department and expressed their satisfaction with the quality supplied. Improved varieties of paddy and sugarcane were introduced through some societies while improved methods of cultivation were shown to others. Cotton seeds were distributed in some areas and the cultivation of groundnuts introduced through these societies. In Rangpur the Agricultural Department gave most useful assistance to a

society which prepared and manufactured tobacco of the Sumatra variety. Everywhere the relations between the two departments are becoming more and more cordial and the Registrar remarks that if the Agricultural Department develops seed stores they may find the societies foremost among their clients.

Bihar and Orissa. The number of Agricultural Credit Societies rose from 1,337 to 1,616, their membership from 56,200 to 60,778 and working capital from Rs. 21,61,057 to Rs. 29,81,629 during the year. The working capital per head of members however is still very low, being only Rs. 49. This figure excludes the possibility of making loans for carrying out agricultural improvements or for adopting improved methods of agriculture and gives an indication of the immense field for co-operative finance which is still to be covered. The agency of co-operative societies and central banks is being increasingly utilized by the Agricultural Department for propaganda work, chiefly in the matter of supply of seeds, manures and implements. To quote a few instances: The Nawada Central Bank stored 366 cwt. of Pusa 12 wheat and requisitioned another 366 cwt. from the Agricultural Department. The Central Bank of Bihar stored 586 cwt. of castor cake to be sold among its members for manuring potatoes. The Central Bank, Supaul, purchased 20 sugarcane mills and distributed them on loan to the societies. As regards co-operative societies other than credit, some progress has been made in organizing them for joint sale and purchase. The Fatwa Co-operative Stores has been formed with the object of saving the ryots from the necessity of selling their grain when the price is low. The store receives all the grain from its members, paying them at the time a portion of the price to enable them to tide over their immediate requirements. The grain is sold when the market is most favourable and the balance of the price is paid to the owner after deducting a small commission. This society has made a good beginning and promises to do well in future. Three Co-operative Agricultural Associations were started during the year at Barh, Nawada and Behar. In each of these centres the demand for improved seed and manure was growing every year and hitherto the work of popularizing and distributing these was done by

the Central Banks. A separate organization with specific objects has now been created with a view to make better progress in this direction. The objects of these associations as defined in the bye-laws are (1) to arrange for the supply of seed, manure, implements, etc., for the members, (2) to undertake the sale of the members' produce in bulk and (3) to enter into any other business calculated to assist the members in the cultivation of their lands. Breeding bulls have been distributed to the various co-operative societies and a scheme for making each Guaranteeing Union a centre for improving the breed of cattle is under consideration.

United Provinces. The number of Agricultural Societies fell from 3,008 to 2,877, membership from 102,312 to 92,040, while the working capital decreased from Rs. 51,36,051 to Rs. 48,61,522. The decrease is due to the liquidation of 253 societies, while new registrations amounted only to 122. Loans were largely given for the purchase of bullocks and seed and for the payment of rent. There are now 13 Agricultural Non-credit Societies in this province, 4 for cattle insurance, 8 for production and sale (5 of which are *ghee* societies and 3 dairies), and 1 for purchase and sale. Of the *ghee* societies 4 are working well though their progress is slow. The possibilities for such societies are great as there is a good demand for *ghee* and the article is not of a perishable nature. The society which deals in the purchase and sale of agricultural produce is the Mainpuri Agricultural Supply Society. Its object is to produce and supply improved seed not only to the members but to the whole locality. It distributed 153 cwt. of Pusa wheat during the year and has stocked 569 cwt. for distribution in the current year. A large number of Central Banks continued their endeavours to spread the cultivation of Pusa wheat, Aligarh cotton, *buri* cotton, Mauritius and Saretha canes and Jaunpur maize to the advantage of their members. They take special measures to procure and stock good seed. The Central Bank at Sandila is also trying to popularize the idea of joint sale of grain on a large scale by demonstrating its advantages to the members.

The Registrar remarks that with the spread of the spirit of co-operation in the rural classes substantial impetus to agri-

cultural development is bound to come. The need of the present is to lead, with judicious help and patience, both co-operative and agricultural development to proceed on sound lines, and this is being done in close co-operation by the two departments concerned.

Punjab. The number of Agricultural Societies rose from 3,417 to 3,937 during the year, while the membership declined from 129,544 to 125,040 and the working capital from Rs. 1,40,70,943 to Rs. 1,37,52,460. The decrease is due to the removal of undesirable members and the heavy withdrawals of deposits on account of the war loan. Current agricultural requirements such as purchase of cattle, fodder, and seed, land improvement, etc., account for a large proportion of the loans issued. Twenty-one per cent. of the loans went for repayment of debts. The Co-operative Department is getting into closer association with the Agricultural Department. A portion of the staff attended the 6 months' vernacular class in practical agriculture at Lyallpur, while others went for a week's training. In the words of the Registrar, the result has been to arouse interest and enthusiasm in the development of agriculture and to bring about a closer relationship with the officers of the sister department. The Co-operative Department disposed of 352 implements, mostly Meston ploughs, to members and 111 to non-members. It may be mentioned that this Department have sold exactly 1,000 improved implements in two years and although this constitutes a very small replacement of the *desi* plough, it is distinctly promising. A marked advance has been made in seed distribution; over 1403 cwt. of wheat seed and 123 cwt. of cotton seed have been supplied to members from stock supplied by the Agricultural Department. Over 732 cwt. of Chari seed, which 2 years of excessive rains had made difficult to procure locally, was obtained by the Agricultural Department and distributed through societies. The seed has everywhere met with approval. Arrangements have also been made by societies to store several thousand maunds of selected wheat seed. A society which has recently been formed in Shakargarh for the sale of wheat on commission proposes in future to store 732 cwt. of wheat seed and has built a godown for the purpose

An effort will be made to persuade Unions to follow its example though on a smaller scale. With a view to popularize the improved methods of cultivation recommended by the Agricultural Department and to reach the villager who will not go to see an agricultural farm, an experiment in demonstration plots run by leading members of a co-operative society has been initiated in the Gurdaspur and Jullunder Districts. It is hoped that if the experiment succeeds Unions will in time employ their own Agricultural Assistants to supervise this work.

There are 8 Agricultural Supply Societies with 280 members and 34 new societies for production and sale. Of these 31 are for the sale of American cotton. The societies insist upon the members growing only pure American and uprooting all plants of *desi* varieties. They also seek to encourage the adoption of better methods of cultivation and to ensure a supply of pure seed. The Co-operative Department proposes gradually to take over the auctions of American cotton from the Agricultural Department. If the operations in this cold weather prove successful a large expansion in this direction may be expected.

There are 3 *ghee* societies in Karnal. They met with considerable difficulty in finding a market for their pure *ghee*. The stuff in the market is heavily adulterated and it is difficult to find any one who will undertake to sell it in its pure state. In Gurdaspur a milk supply society has been started, but it has not found the public ready for the pure article (a state of things which speaks for itself). It supplies milk to students, invalids in the jails and military patients.

Burma. The total number of Co-operative Societies in Burma rose from 2,575 to 3,056 and the membership from 61,105 to 73,702 during the year. The difficulty of adequately financing Agricultural Credit Societies in Lower Burma for long-term credit is thus commented upon in the Registrar's Report :—

" It is becoming apparent that even under normal conditions it will be difficult to meet such requirements (loans for land purchase, settlement of large debts, etc.,) in Lower Burma by the present methods of co-operative finance. The value of land is high and permanent indebtedness is high in proportion. It

is practically an impossibility for the member engaged in clearing his debts or in the extension of his holding to repay loans contracted for the purpose in four years, while the banks depending as they do for their funds on deposits with a maximum period of five years, cannot afford to see their money locked up in long-term loans. Such long-term loans are however becoming a necessity for agricultural finance in Lower Burma. The question has received some consideration during the year, and the solution appears to be in the issue of long-term or irredeemable bonds secured on land mortgages. This class of business is undertaken by special land mortgage banks in Germany. There is reason to believe that such bonds might obtain a sale in Burma if carrying a rate of interest equal to that usually obtained by landlords from their land and the matter seems worthy of further examination. The general opinion among co-operators appears to be that the issue of such bonds by the Provincial Bank would be preferable to the formation of special mortgage banks. Further attention will be given to the subject during the coming year and, if possible, proposals will be submitted for dealing with it."

A special feature of co-operation in Burma is the colonization of special areas (the Mon canals tract and parts of Hanthawaddy, Pegu, Yamethin and Myitkyina districts) by co-operative agency. Some of the societies in the Mon canals tract have succeeded in establishing themselves or are likely to do so in the near future.

As regards Co-operative Sale Societies there were 46 at the end of the year. Of these the Hopin paddy sale society is the most successful. The low prices for paddy prevailing during the year have aroused general interest among Lower Burma co-operators in joint paddy sale business and several sale societies may be expected to begin working next year. Almost all the sale societies in operation are temporary institutions formed for the purpose of the year's business and finally wound up at its close. An attempt is being made to provide for a more permanent organization in the case of the paddy sale societies now being started in connection with several Lower Burma Unions, but an agency in Rangoon appears to be essential for the successful working of these societies.

Central Provinces. The number of Agricultural Credit Societies rose from 3,267 to 3,377 during the year under report. The number of members increased from 52,757 to 55,663 and the working capital from Rs. 48,11,831 to Rs. 57,48,913. Nearly 74 per cent. of the loans advanced are for purchase of plough cattle and seed, cultivation expenses, sinking of wells, making of embankments, etc. A special feature of the development of the co-operative movement here is the formation of the Central Provinces Co-operative Federation. Each Central Bank with its constituent societies is a member of the Federation. A non-official co-operator has been appointed as Governor in accordance with the wishes of the majority of the members of the Federation. He is primarily responsible for organization, supervision and propaganda and the control of the Federation staff. The Registrar continues, as required by the Act, to control the audit of societies but is no longer directly responsible for the financial management. A link is also established between the banking system and co-operative system by the fact that the Governor of the Federation is also practically Managing Director of the Provincial Bank. The co-operative movement in the Central Provinces has thus advanced a distinct stage towards the ideal that in the end the whole co-operative system shall be owned and controlled by the agriculturists themselves and their representatives.

As regards agricultural societies for purposes other than credit, a full description was given in the last year's report. On account of the poor cotton crop the operations of Agricultural Unions in Berar were necessarily restricted. The financial position of many of the members forced them to dispose of their cotton before it was ginned. It is essential for the future progress of these Unions that some agency should be devised for the sale of their pure *roseum* cotton seed and *kapas*. This agency by purchasing the necessaries of agriculture and selling the produce on behalf of the Agricultural Unions should in effect perform those functions which the Central Bank fulfils on the credit side in relation to its constituent societies. Tentative steps have been taken in this direction and with this end in view a Taluk Agricultural Association has been registered at Khamgaon with an authorized share capital of Rs. 5,000. The

association has made a modest beginning and hired out Turnwrest ploughs and conducted the sale of implements, feeding cake, and seed. For the present the association will deal in the sale of *roseum* cotton seed only and will not undertake the sale of *Kapas* until further experience is gained and until it can afford to employ the necessary trained staff. We look for a development of societies on these lines in future.

As regards co-operative breeding societies the one at Nawagaon handed over 15 young bulls to its members during the year. But very few of the members take any real interest in the society and the management continues to be left very largely to the staff of the Agricultural Department. Since its reorganization last year, the cattle breeding society at Khandwa has made much better progress. During the year the society made over 71 young bulls and 27 heifers to the members. Both these societies worked at a profit. Developments in co-operative dairying are detailed below.

Assam. The number of Agricultural Credit Societies in Assam remained the same as last year, *viz.*, 313. Membership declined from 16,732 to 15,950 and the working capital from Rs. 4,65,945 to Rs. 4,59,774. The decrease is due to the abnormal increase in the price of the necessaries of life and the stringency of the money market, etc. There are no agricultural societies for purposes other than credit.

Co-operative Dairies.

There are 11 Co-operative Dairies in the Bombay Presidency. The Registrar reports that the hope expressed last year of an improvement in the management of dairies has been belied and there is little progress to record. The dairies previously organized amongst the urban *gaolies* carry within themselves the seeds of failure and will probably have to be wound up in time. Those that aim at bringing milk to a city market from surrounding villages and at distributing it are much more promising.

The two Gaolies' Co-operative Societies at Nagpur formed in 1913 and 1914 made a profit of over Rs. 5,000 in the year under report. Arrangements are being made to increase the

number of good milch animals and to get rid of most of the young stock and of the inferior milch animals kept at present. The coupon system of cash payment introduced last year has proved a thorough success from the business point of view. The problem of timely distribution has also been solved to a great extent by the use of a motor car. Mr. Clouston reports that a wonderful change has come over the *gaolies* since they became members of these societies. They are now much more amenable to reason and with few exceptions are good, law-abiding citizens.

There are now six Co-operative Milk Societies in Bengal. The members are all cultivators and cow-keeping is a secondary business with them. The milk is brought under seal in locked cans to Calcutta and is sold to consumers there as it came from the cow. The consumers are invited to record complaints and the municipal officials to test the milk. The society tests the milk before despatch and it is tested again on arrival in Calcutta. So far comparative success has attended this experiment and the members get a better price for their milk: but the cost of management is at present high owing to the fact that the societies though close together will not combine. Each society sends a man with its milk to Calcutta. With the development of more societies it will be possible to bring the whole supply to Calcutta by motor and to reduce transport and other charges. The Dacca Co-operative Dairy is now a purchase and sale society. It advances money to the societies which supply it with milk. It worked at a profit this year.

In Bihar there were 2 societies for supply of milk, one at Bhagalpur and the other at Gaya both within municipal limits. The quantity of milk supplied during the year by the former society amounted to 27,880 lb. The latter society had to be dissolved as the members proved to be quite beyond redemption. It may be added that the milk problem will never be solved without the aid of legislation; not only are the *gaolies* as a class hereditarily averse to sanitary measures, but it is a regrettable fact that the general public are in many cases not ready or prepared to pay for pure milk and this greatly handicaps any *gaoli* who may do his best to sell it. Until the municipalities

are empowered to evict if necessary all the *gaolies* from municipal limits and settle them outside in a place where there are facilities for grazing as well as for fodder growing and some sporting chance of sanitary conditions being maintained, no substantial improvement can be expected. The milkmen will never be loyal to their societies until municipalities introduce milk regulations which will place *gaoli* non-members on the same footing as members in the matter of discipline.

The co-operative dairy at Allahabad is flourishing. It made a substantial profit on the year's working and distributed a fair bonus on the price of milk supplied by the members in the previous year. It has got a good reserve fund. It may be mentioned that the society allows no credit sales and this has a considerable bearing on the present favourable financial position.

The Benares dairy made a small profit but not sufficient to cover interest charges. The membership has increased but the members find it difficult to sell to the society with advantage milk at 20 lb. to the rupee. The Allahabad society's rate is 18 lb. When the society tried to raise the price of milk, the sales dropped and it had to revert to the old rate. The expenses of the dairy have been reduced to the minimum, but unless the people are prepared to pay better prices for good milk no real improvement is possible.

The Lucknow dairy is dwindling. Since January, 1915, its membership has gone down from 40 to 17. During the last year alone 16 members left the society. The society combines credit with milk business. The actual collections were very small and there are large overdue loans yet to be repaid.

It is quite obvious that with regard to co-operative dairies the question of public support must be dealt with. If the general public is neither prepared to use nor pay for pure milk but prefers the cheaper adulterated products of the past, then on its own head be the evil and it is self-evident that it is a case of "by their deeds and not their words shall ye judge them." It is absolutely useless to expect that a pure article can be sold at the same rate as an adulterated, and if the value placed on

infant life is so small and the attitude of the public so reactionary nothing but legislation will cure it.

Cattle Insurance.

It would be well at the outset to clear certain misconceptions regarding the practicability of cattle insurance in this country. It has been suggested that nothing can be done until the inoculation of cattle is possible. It must, however, be stated that inoculation, though very important in dealing with contagious cattle disease, is chiefly valuable as an adjunct to other methods, and that the best method of operation is by the instruction of the people in the proper care of their cattle. India is essentially a cattle country and has been from time immemorial, but the total and abysmal ignorance of the population, rich and poor, with regard to the health of their livestock is one of the most lamentable features. The main consideration is the spread of education as to proper housing and feeding, and this is difficult owing to a general absence of public spirit and public opinion, one man not caring what happens to another man's cattle. The creation of such a public opinion is one of the great advantages of co-operative societies whose members will listen to the warnings of an inspecting official as isolated individuals would not.

The general adoption of inoculation by the serum alone method is not necessary before taking up cattle insurance as the immunity conferred by serum is only temporary. Cattle insurance societies should be responsible for reporting outbreaks, and in their own interest they will use their influence to get their members to adopt segregation and other preventive measures and to arrange for inoculation as soon as an outbreak occurs.

Such societies should not be formed unconnected with Co-operative Societies. These latter can provide accurate data for the mortality of cattle in the village and the right amount of premium to be charged can be arrived at after short experience. In order to spread the liabilities over a large area, a central reinsurance society is desirable where the number of societies affiliated to it is large enough to admit it.

The number of Cattle Insurance Societies in Burma has increased from 324 to 379 though all of these are not actually

working. Some improvement is recorded in the working of societies actually in operation; death reports have been punctually submitted and indemnities paid out with less delay than formerly. There was a fall both in the amount of risk insured and in the premium collected. There is no doubt that the premia now demanded are unduly high, but the idea of insurance is not unacceptable to the people and it should not be impossible to discover suitable modifications to make it popular among all co-operators.

A passed student of the Bengal Veterinary College has been attached to the Upper Burma Central Re-insurance Society and is spreading among the societies better methods of flaying and preparation of hides. If these instructions are followed the prices obtained by the cultivators for their hides will be greatly increased. This will tend to reduce the premium to be given and thereby help the expansion of these societies.

The funds accumulated by the Upper Burma Central Cattle Re-insurance Society now amount approximately to 9 per cent. of the whole risk reinsured by it. This is a very satisfactory result of 3 years' working and shows that the society has little or no need of the assistance of Government.

In the Bombay Presidency the four Cattle Insurance Societies formed last year started work. The cattle are insured up to two-thirds of their estimated value as determined annually for a period of one year only, renewable with the consent of both parties and the premia are calculated at the rate of 5 per cent. of the sum insured.

There are four such societies in the United Provinces. One society in Budaun was liquidated. The Registrar reports that the working of these societies has not so far been successful. The main difficulties mentioned by him are the frequent changes made by the members in their cattle, their unwillingness to deprive the village *chamars* of their customary right of appropriating the carcase in return for which they get a pair of shoes or a bucket, and above all their lack of comprehension of the working, and of faith in the benefit, of such societies. Steps are being taken to stimulate interest and different constitutions will be tried with a view to see which is likely to succeed best.

Four societies for the insurance of cattle have been started in the Punjab but only one was registered during the year under report. The outlook seems promising and under favourable conditions success should be within reach.

Cattle insurance is well established in Coorg where not less than 10 societies are working successfully.

A table showing various details about the working of non-credit agricultural co-operative societies in British India during the year 1917-18 forms Appendix II to which reference should be made by those interested.

CHAPTER IV.

PROGRESS IN AGRICULTURAL EDUCATION.

As the Hon'ble Sir Claude Hill remarked at the last meeting of the Board of Agriculture in India, widespread agricultural education is a necessity if all the work which the Agricultural Departments in India are doing is to reap the fruit which the amount of the labour expended entitles us to hope it will. In this connection an instructive article on the subject by Mr. H. M. Leake has appeared in the *Agricultural Journal of India*, vol. XIV, part I.

In all discussions about education one must remember that the type of education to be provided is influenced by the conditions of the country and the limitations imposed by the system of educational finance. The main function of education is to render the individual a useful citizen. This does not mean that born an agriculturist, a man should remain an agriculturist. It only means that the education of the majority should be such as will fit them to fill the station they are most likely to occupy in life, *viz.*, that into which they are born. Of course a ladder should exist by which individuals in any particular station can ascend, if so fitted, to a higher one. Now in India over two-thirds of the population is directly dependent upon agriculture and in devising a system of education for them, we have to look to the needs of the two different classes which constitute the agricultural population. For sub-tenants and labourers whose children begin to take a share in the family labours at a very early age, the simplest primary education is all that can be provided. As regards zamindars, large cultivators and occupancy tenants, such education should be provided as will fit them to return to the land and take an active interest in the improvement of agriculture and of village life generally. For one must bear in mind that the world's progress is affecting agriculture equally with other occupations, and that the man who will succeed is he who most clearly appreciates this progress and most quickly profits by the new markets and new opportunities opened to him.

The present educational system in some respects fails to satisfy the needs of a large section of the community. What is wanted and wanted urgently is the development of a form of education which will leave the average country youth fitted for life in the surroundings in which he is born. There is ample scope in such surroundings for the educated man to find full and useful employment and to fill the rôle of a useful citizen.

While agricultural colleges fulfill a useful purpose in training some of the students of the large landholding classes, in providing teachers for agricultural schools, and in turning out recruits for the Agricultural Department, they are not enough for the agricultural needs of the country. A cheap form of secondary education, complete in itself and complete so far as is possible having regard to the age at which the average boy leaves school, is also required. We mean schools supplying an education fitted to the needs of the mass of the agricultural population and at a cost which makes possible their establishment in numbers sufficient for the accommodation of the available pupils. The primary object of such schools should be to raise the receptivity of the younger generation of agriculturists and the method of attainment must be through education under conditions which retain an association with the land. The courses of instruction should be *educational*, not vocational, and the students should be introduced, by a process of familiarization, to an appreciation of a standard of country life, something superior to the ordinary village life they have known. If care is taken to provide a course which teaches accuracy in all matters and creates an interest in things round about them and in the sciences which lie at the root of agriculture, the students at the end of their career will be fitted to return to their homes and to the realities of life with a sense educated to realize the more backward conditions and *a will to remedy them.*

The question now arises as to the ladder to be provided by which such students as aspire to higher knowledge and who are intellectually qualified can fulfil their ambition and rise in the social scale. The natural evolution seems to lead up to the Agricultural College or the University. As the difficulty of providing qualified teachers for this type of schools is at present serious, development will be slow: but this slow development

will afford ample opportunity to gain practical experience as to the most desirable form of extension in this line.

We will now review briefly the principal educational activities of the year under report.

The number of students taking the graduate course at the Poona Agricultural College which is affiliated to the Bombay University is steadily increasing and now stands at 135 as against 117 last year and 87 in 1912. The new syllabus is generally admitted to be an improvement on the old one and the teaching better. Mr. Keatinge confidently expresses the opinion that the students who leave the college now are better trained than was formerly the case. They are in demand outside the Bombay Presidency and outside India, while many of them are now successfully cultivating their own lands.

The special grant for agricultural education made by the Government of India will enable the department to have a compact area under a canal which could temporarily be leased out to suitable students in small areas suited to their requirements, whereby passed students of the college thinking of setting up for themselves as farmers could gain practical experience without undue risk and afford each other mutual assistance and obtain help from the department when required. After a few years of farming under these conditions they would be in a position to make way for new comers and to pass on to independent farming on a larger scale.

The Director reports that the college is likely to go ahead very rapidly in the near future and this will necessitate the employment of additional staff.

The year opened with a total strength of 99 students in the four classes at the Coimbatore Agricultural College, and closed with 80 for the three classes still in residence, the fourth class having closed in December when the first batch of men taking the new four year course completed their training. Eight students appeared for the diploma examination and they all passed. Thirty-four students appeared at the examination for the certificate of proficiency in agriculture and 32 passed. Of these, 10 were selected for the higher course and 19 have been appointed to the lower subordinate branch of the service. In addition two

men from this lower service have been deputed to undergo the higher course. The new admissions were only 33 and these are not a very promising lot. Both in number of applications and in quality this year marks a distinct falling back. The Director thinks that the only reason that can be assigned for this is the fact that it coincided with the change in the regulations by which candidates may now take the Intermediate examination of the University of Madras piece-meal. There is very little demand as yet for agricultural education for its own sake, and the Agricultural College at Coimbatore is looked on as a cheap way into the Government service if the main way through the University fails.

The introduction of a second series of classes in which attention is paid to such subjects as drawing, arithmetic, and mensuration has been found successful and will become a permanent part of the two years' course. At the desire of the United Planters' Association of Southern India, a short special class was held for estate-writers with a view to give them some training in the diagnosis and treatment of various pests and diseases of rubber, the destructive power of which is becoming increasingly realized. Instruction was given to eleven men for two months. The results were satisfactory and the course will be continued and expanded.

The number of applications for admission to the Agricultural College at Nagpur reached a record figure this year. Twenty-seven students appeared at the examination of the two years' course, of whom 20 passed. The Principal is of opinion that a slight alteration in the two years' course is necessary. In the first year more mathematics should, he thinks, be taught and a course of lectures in English should be given. In the second year he is arranging to give more time to the study of physics and botany so as to prepare the way for the teaching of these subjects in the third and fourth years. More attention will be given to the teaching of mechanics, anatomy and physiology. These changes will result in less time being devoted to purely practical work in the first two years and in more time being given to the study of sciences allied to agriculture. The effect will be to make the two years' course much more popular and to afford more real education to the students.

The agricultural scholarships given to boys at high schools have not yet been the means of bringing many students to the college, but the principle on which these scholarships are given is sound and should in the long run produce good results.

At the Sabour Agricultural College, 9 students sat for the last diploma examination, of whom 7 were successful and one was awarded a certificate as his general results were not good enough for a diploma. Twelve students appeared for the first final examination of the certificate class (2 years' course) and 8 were successful. One hundred and forty-eight applications for admission into the college were received for the session 1918-19. Of these only 45 turned up for the entrance examination and 31 were admitted. The total number of students in the college was 51, of whom 32 came from Bengal, 10 from Assam and 9 from Bihar and Orissa. It is a somewhat peculiar position to find a provincial college 80 per cent. of whose pupils are drawn from other provinces. More chilling perhaps is the fact that the number of pupils from the province itself is exceeded by those from one of the smallest provinces in India. There seems to be very little demand for agricultural education in Bihar and Orissa. With a view to encourage a study of agriculture among the people of the province and to obtaining suitable recruits for the newly created posts of District Inspectors, Government sanctioned the grant of 9 stipends of Rs. 20 each per mensem to boys having a fair knowledge of English and elementary mathematics for training on farms for a year or so prior to their admission to the Sabour College.

The Cawnpore Agricultural College opened its session with 97 students, of whom 50 were in the diplomate course and 47 in the two years' or vernacular course. The first batch of four-year students passed out during the year; nine out of 10 obtaining their diplomas. During the year there were 45 applicants for the four years' course, of whom 19 were admitted. Three passed students joined the Labour Corps for Salonika. There were several offers, to passed students of this college, of posts in Mesopotamia.

Mr. W. Youngman of the Canning College, Lucknow, has now relieved Mr. Leake of the botanical teaching at the college as he

has joined the department as Assistant Botanist. During the year an additional agricultural lecturer has been appointed and sanction obtained to the substitution of an extra agricultural lecturer in place of the English teacher whose post has been abolished. Except therefore for the appointment of an agriculturist the staff is now of sufficient strength.

The Agricultural College at Lyallpur worked for the first time as an affiliated college so that the teaching given to the first year class was for the University course. Arrangements were made for admission of large landholders and men from the Chiefs' College, Lahore, and also students from Sind. The demand for admission to the college is getting keener every year. The number of applicants rose from 150 in 1917 to 223 in 1918, of whom 53 were selected. The Principal reports that he was able to select a large number of matriculates who had passed in the first division. Six students appeared at the diploma examination and all passed, and the same was the case with the 34 students who appeared for the leaving certificate examination. In addition to supplying 2 men to the Signal Company the college was asked to supply 15 Agricultural Assistants for Mesopotamia.

Assistant Professors in chemistry, botany and English have been added to the staff. Three Demonstrators have also been sanctioned, of whom one has been recruited so far. These additions to staff were necessitated under the regulations of the Punjab University to which the college is now affiliated.

In Burma proposals for the establishment of an Agricultural College at Mandalay, based generally on that of the Central Provinces, are now in process of submission to Government. Such an institution is obviously necessary if a staff adequate to the proper agricultural development of a province of the size and importance of Burma and containing such diverse conditions is to be secured. In the meantime four Agricultural Assistants have been sent to the Poona Agricultural College and two District Agriculturists were trained at Mandalay.

In the Agricultural School at Hebbal in Mysore where a two years' course is imparted through the medium of English, 16 students sat for the final examination of whom 11 passed. Of the total number of 33 students in the school, 15 were scholar-

ship-holders. The students of the school are conducting successfully a night school for the benefit mainly of the farm coolies.

The Agricultural School at Chikknahalli completed its second year of existence. There are eleven students on the rolls. At the examination 8 students were declared eligible for the Leaving Certificate. It may be mentioned that students are given a practical course in blacksmiths' work and also do all the carpentry work required.

Higher education in agriculture and its allied sciences is provided for at Pusa where post-graduate courses are given. During the year under report 3 students were trained in agricultural chemistry, one in mycology, 2 in general agriculture, 5 in agricultural bacteriology (including bacteriological technique in silkworm disease) and 2 in entomology. Besides these one private student worked in the Mycological Laboratory for a short period. It is hoped to raise the level of post-graduate training at Pusa to the same standard as that in England and elsewhere, so that facilities for teaching up to the highest standard may be available when provincial colleges can find material likely to profit by it. It is not desirable that Pusa should waste its time in elementary training which can be given at provincial colleges.

The progress made in vernacular agricultural education and the improvement of rural education may now be briefly noticed.

As noted in previous reports, short courses in agriculture are given in vernacular in some provinces.

In the United Provinces there is a two years' vernacular course attached to the Cawnpore College. The institution of this course and its location at the college is admittedly a temporary arrangement. The age for admission is the same as for the four years' diploma or collegiate course. During the year there have been two final vernacular examinations due to the reorganization of the session. The first was held in August 1917, and the second in April 1928; 42 students in all appeared at these two examinations of whom 33 passed.

There were a hundred applicants for this two years' course of whom 29 were admitted. This indicates that there is a grow-

ing demand for an education in which the teaching of practical agriculture is a prominent feature.

A vernacular class is also held at Lyallpur. There were 101 applications for admission to this class. In all 37 students were admitted. Thirty-one students appeared at the examination and all passed. The department proposes to start in future similar classes at Gurdaspur and Hansi. The training given in this vernacular course is capable of immediate practical application when the boys return to their land; a few pupils from this class are taken on as Mukaddams in the department. The value of the teaching in connection with the district work of the department is, therefore, very great and should be regarded as important in any considered scheme of agricultural development and progress.

The Board of Agriculture at the last meeting held at Poona in December 1917, resolved that a sound system of rural education based on rural needs is essential and that—

(*a*) The demonstration of improved methods of agriculture is already creating and is likely to increase a demand for improved rural education, and that the latter will in turn facilitate agricultural demonstration. That as this process advances a demand wil probably arise for definitely agricultural schools.

(*b*) Preparation should be made for this latter probable demand by the early establishment, as an experimental measure, of a very limited number of Agricultural Middle (Madras Upper Primary) Schools (say one or at most two in each important provincial language area).

(*c*) If, as a result of these experiments, further agricultural schools (as distinguished from ordinary rural schools) are to be started, it is of the utmost importance—

(*i*) that their object should be to send their pupils back to their own land;

NOTE.—The Board drew up tentative proposals regarding a syllabus and organization to indicate the nature, the scope and the standard of instruction that is contemplated. These proposals will be found in the appendix printed on pp. 91 and 92 of the published Proceedings of the Board.

(*ii*) that the rate of the increase in the number of the schools should not be allowed to outstrip the rate of the provision of properly trained teachers;

(*iii*) that the training of the teachers should as far as possible be thoroughly practical on the agricultural side and should in its final stage be connected with one of the schools already successfully established;

(*iv*) that the schools should be made as nearly self-supporting as possible;

(*v*) that each school should generally be on or in the neighbourhood of a demonstration farm.

There are four vernacular agricultural middle schools in the Bombay Presidency. For details about these schools reference should be made to Appendix III. In this connection we make the following extracts from Mr. Keatinge's report: "Most of the boys are keen and the tone is good. I think that the schools are doing valuable work. We are about to take over Sardar Bivalkar's school at Alibag immediately and to convert it into an agricultural school of the Loni type. The school near Godhra for the Gujarati districts projected some years ago, but held up for financial reasons, is now under construction, and the Government of India have made a special grant which will enable us to start three more such schools, probably in the Nasik, Satara and Bijapur districts. There is no doubt that the idea of these agricultural schools is popular, and we have demands for the opening of such schools from many quarters. Government has approved of the programme of opening one such school in each district, as funds permit. With the increase in the number of these schools, provision for adequate inspection becomes necessary. I have submitted proposals for the appointment of an Inspector of Agricultural Schools and anticipate good results from the appointment."

Two agricultural middle schools are under construction in the Central Provinces. A beginning has also been made at the Chaurai vernacular school to adapt the teaching to the needs of the rural population and vacation classes are to be held for teachers on the Nagpur and Chandkhuri farms in the coming year.

In the United Provinces arrangements have been made for opening a middle school for agriculture taking in boys from the age of 15 to 17. It will be mainly for the sons of the smaller zamindars and larger occupancy tenants who will have land on which to practise what they have learnt at the school.

A class for vernacular school teachers has been started at Lyallpur. The provision of trained teachers is a matter of first importance, and it is on this that the success or failure of all schemes of rural education must depend.

In Mysore rural science classes have been organized in four selected village schools for pupils of 12 years and over. The instruction is in charge of teachers who in addition to their own training at the Normal School at Mysore have undergone a course at the Hebbal farm. It is inspected very frequently by the Rural Science Supervisor. Work in one school had to be discontinued for want of a sufficient number of students and of suitable land in the vicinity for practical instruction. A second short course was held on the Hebbal farm for the benefit of village school masters who will be eligible for employment when the scheme of rural instruction is further developed.

In Travancore elementary agriculture still forms part of the curricula of studies in classes V, VI, and VII of the vernacular schools. Last year more than 4,000 boys took the subject for the vernacular school-leaving certificate examination. The two night schools started by the department in 1916-17 for the purpose of imparting elementary agricultural instruction to the boys of the cultivating classes continued to work satisfactorily and a third night school was opened during the year. More than 50 boys are now attending these schools.

The account given above shows what is being done for the education of rural children and grown up boys. But so long as the mass of cultivators are illiterate it is most necessary to convince them that there is something more to be learnt even in their occupation than the traditional lore handed down from father to son. The Agricultural Departments are therefore demonstrating the possibilities of improvement as the result of application of scientific methods, etc., and by holding on departmental farms short courses for particular improvements are

showing them that the department knows more than they do; that it pays them to adopt the improvements and that they can make their calling more remunerative than it is at present. Where these advantages have been clearly appreciated by the cultivators there is a genuine desire for sending their sons to agricultural schools, and in this largely lies the hope of the future agricultural regeneration of India.

CHAPTER V.

PROGRESS IN VETERINARY WORK.

It is proposed to review the work done by the various Provincial Veterinary Departments and the Imperial Bacteriological Laboratory at Muktesar under the following heads :--

1. Administrative changes and health of stock.
2. Preventive inoculation and legislation.
3. Cattle-breeding.
4. Sheep-breeding.
5. Veterinary education.
6. Veterinary research.

The department is much understaffed and considerable expansion is necessary if prophylactic measures for the cattle, which are the backbone of the Indian cultivator's prosperity, are to be provided on an adequate scale. Much educative work requires to be done in the districts by the veterinary staff before people will begin to understand the ways in which contagious diseases can be avoided and kept under control. This can only be achieved if more staff is provided.

1. ADMINISTRATIVE CHANGES AND HEALTH OF STOCK.

Bombay. Colonel G. K. Walker, C.I.E., held charge of the department throughout the year. Out of the subordinate staff of 89 men 5 were on military duty and 8 posts were unfilled.

As regards contagious diseases the total mortality recorded this year was only 21,137 against 25,801 last year. Among equines there were 230 deaths from surra but, as equine diseases are very rarely reported by the revenue officials, these figures cannot be regarded as a complete indication of their prevalence. Among bovines rinderpest claimed 13,944 victims against 18,502 last year. Hæmorrhagic septicæmia was widely prevalent affecting all the districts; 5,323 deaths were reported against 2,229 in the previous year. More dispensaries are urgently required, but owing to want of funds many District Local Boards are reluctant to undertake their share in the maintenance of

these institutions. One case of Johne's disease was detected in a buffalo belonging to the Agricultural Department's dairy farm at Poona. This is the first time the disease has been discovered in the Presidency, but it is probably much more prevalent than hitherto realized, and it will be made the subject of further investigation. Colonel Walker states that the work is developing in every direction and the need of more superior staff is becoming an urgent matter. Proposals have been submitted for an increase and for a simultaneous scheme of decentralization, the necessity of which has been previously pointed out.

Madras. Mr. Aitchison, Principal of the Madras Veterinary College, held charge of the office of Superintendent in addition to his own duties from the 1st April, 1917, to 12th November, 1917, when Mr. F. Ware, the permanent Superintendent, again took over charge. The post of Second Superintendent sanctioned by the Secretary of State could not be filled on account of the war. Since the close of the year proposals for increasing the number of Deputy Superintendents to four have been sanctioned by Government. There was a net addition of 10 in the subordinate staff. Two more Inspectors' ranges have since been sanctioned. With a view to accelerate the rate of establishment of veterinary institutions, the Government of Madras have instructed the Superintendent to submit annually a list of six places where such institutions can be opened in the next but one succeeding financial year. It is hoped that at least six will be opened every year regularly in future. There is a steady increase in the mortality of cattle from disease as will be seen from the following figures :—

Year	Total
1913-14	50,728
1916-17	68,588
1917-18	70,018

The increase is due chiefly to rinderpest. This disease has been found to follow the movements of cattle from the States of Mysore and Hyderabad. The Government have therefore arranged, as a preventive measure, for the posting of additional Assistants along the frontier taluks. The provision of hospitals and dispensaries in the frontier taluks also forms a special

feature of the rinderpest campaign and Collectors of districts have been instructed to close cattle fairs and markets during the prevalence of this disease in their districts. In view of the importance of minimizing the ravages of rinderpest it is hoped that all district officers will co-operate in impressing upon the public the necessity of taking full advantage of the advice and assistance of the trained staff which is now available in every district. Mr. Shilston, Second Bacteriologist at Muktesar, who visited the Presidency in connection with the question whether it is feasible and desirable to modify the inoculation system now in force in the Presidency, has recommended the adoption of the simultaneous method of inoculation where conditions are suitable, *viz.*, at Government, municipal and local fund institutions and in the case of cattle belonging to enlightened private owners. If the results are favourable it would be an object lesson to the ryots.

Glanders, from which this Presidency had hitherto been free, made its appearance during the year and a special officer has been appointed to investigate the disease in the city of Madras.

Bengal. Lieutenant-Colonel A. Smith remained in charge of the department in addition to his duties as Principal of the Bengal Veterinary College. The total number of Assistants doing military work during the year was eight. There was an unusual increase in the mortality of animals from contagious diseases, the total number of deaths reported being 26,486 as against 8,415 in the preceding year. This is largely due to the fact that in the most seriously affected districts reports of outbreaks of cattle diseases in the interior were received late, and as, unfortunately, no precautionary measures were taken by the villagers, the contagion spread, with the result that a very large number of animals died before inoculation work could be undertaken. Rinderpest alone was responsible for 21,126 deaths as against 5,443 in the previous year. Hæmorrhagic septicæmia and anthrax came next in order, being responsible for 2,407 and 1,633 deaths respectively. Leaflets in Bengali, dealing with the prevention and treatment of contagious diseases, were freely distributed to the villagers, and the benefits accruing from

isolation, disinfection and burial of carcases were fully explained to them.

Bihar and Orissa. The department was under the charge of Mr. D. Quinlan throughout the year. Of the subordinate staff three were on military duty. It is reported that as the conditions of pay are not satisfactory candidates for the service have been few and ill-qualified. The Local Government have submitted proposals to the Government of India for a great increase in the supervising staff and more attractive conditions of service for all branches of the department. There has been some improvement in the reporting of the outbreaks of epidemic diseases except in one division. In addition to inter-district reporting, arrangements are being made with neighbouring Provincial Governments and States for communicating news of border outbreaks. The total number of deaths in the province was 21,754 as compared with 26,107 in the preceding year. Of these, 14,390 deaths were due to rinderpest. As mentioned in last year's report, the Ranchi inoculation scheme, which consists in inoculating cattle through the agency of a special staff of locally trained inoculators, was continued in a modified form with a smaller staff (14 against 23) working over a limited area, and recommendations have been made for continuance of the scheme for another five years or until such time as a sufficient number of Assistants are available to take over this work. The supply of sera and vaccines has now been made a charge on the funds of District Boards, and it may reasonably be expected that members of these boards will take a more active interest in the work in view of the charge which it now imposes on their funds.

United Provinces. Mr. E. W. Oliver returned from leave in September, 1917, and took over charge from Mr. S. G. M. Hickey, Second Superintendent, who was officiating for him. Twelve members of the subordinate veterinary establishment were on military duty during the year under review. The total reported mortality from contagious diseases was 17,407. This year surra was much more widespread. Blackquarter and anthrax were responsible for 3,114 and 1,687 deaths respectively. Hæmorrhagic septicæmia appeared in a specially virulent form

and carried off 3,142 animals, and had it not been for the effective prophylactic measures taken by the department very much more serious losses would have occurred. Foot-and-mouth disease levied a toll of 2,854 deaths. In view of the increasing shortage of horses in India brought about by the demand made on the existing supply to meet the needs of the Army, the Civil Veterinary Department has addressed District Boards and other public bodies pointing out the improbability of any improvement in the situation for some years to come, and urging upon them the importance of lending every encouragement and help in the matter of horse-breeding by locating Government sires wherever possible and advising owners to retain and reserve their best mares for breeding purposes.

A vernacular veterinary journal is issued monthly by the Society formed by the subordinate staff of the department.

Punjab. Colonel Farmer, C.I.E., held the post of Chief Superintendent throughout the year. Two Inspectors and 37 Assistants were working in the Military Department. The year was, like that which preceded it, remarkable for the excess of the monsoon rains and the consequent high mortality among cattle. The number of reported deaths from contagious diseases was 30,085 or slightly less than in the preceding year, but Colonel Farmer is of opinion that a large number of deaths from surra have not been reported. Even so, among equines no less than 1,362 deaths from surra against 128 in 1916 were reported. The year was very favourable to its propagation, and the extensive movements of animals partly accounted for its appearance in some places where it had scarcely been known before. With a view to reducing the mortality, owners have been advised to keep their horses in dark stables during the day when biting flies are active. Conferences were also convened to consider measures for prevention of this disease as well as to ensure that its presence is promptly brought to notice. Ten cases of dourine were detected during the year. In view of the widespread extent of this highly dangerous disease, the Dourine Act has been extended to the whole province and the Lieutenant-Governor has recently recommended the amendment of the Act so as to confer more drastic powers on veterinary practitioners and In-

spectors. In the opinion of Colonel Farmer, the time has come for the registration of all privately owned stallions so as to control horse-breeding. But even if adequate steps could be adopted for their control, the effect of the measure would be far from complete owing to the usual practice of leaving horses, which are not kept for stud purposes, uncastrated. Among bovines hæmorrhagic septicæmia and blackquarter accounted for 13,445 and 2,609 deaths respectively. Rinderpest claimed 8,495 victims which is only half the number recorded last year.

That the Veterinary Department in the Punjab is growing in popularity is evident from the fact that whereas in the quinquennium 1900-05 only 30,000 animals were treated in the hospitals, the number rose to an average of 146,000 in the quinquennium ending in 1910, while in the year under report the number of animals treated was 3,60,000. A further sure sign of the steady growth of appreciation shown by stock owners is the fact that the people themselves are beginning to build veterinary hospitals, and cattle insurance is also coming into favour. The department is steadily working for the improvement of cattle-breeding and there are now 1,087 stud bulls at work in the province, an increase of nearly 10 per cent. on the figures for last year.

The Punjab Veterinary Association continues to flourish. Its Journal has been considerably improved and is a very valuable contribution to the vernacular veterinary literature of the country.

Burma. Colonel G. H. Evans was in charge of the department throughout the year with Mr. Rennie as Second Superintendent. Rinderpest was confined to two districts of Lower Burma, *viz.*, Amherst and Insein. In the former district it is reported that the disease was brought in from Siam. The outbreak in the latter district is said to have originated in the vicinity of Rangoon whence it gradually spread, chiefly through the medium of the numerous herds of Indian owned milch and other cattle whose owners are the least educated as regards scientific methods of prevention and control of contagious disease. With the exception of the Bhamo District where over a thousand deaths from rinderpest were reported, Upper Burma may be said to have enjoyed during the year practical immunity from

contagious cattle disease. In the Shan States, generally speaking, the health of stock was unusually good though occasional outbreaks of rinderpest in some parts are recorded.

As regards preventive inoculation and the so-called readiness of the Burman cultivator to have his cattle inoculated, Colonel Evans makes the following remarks: "There may be an impression that cattle-owners in general jump at the opportunity of free serum injection for their cattle; if this is so, it is a fallacy. Very few are really desirous to have it done. Much tact, patience, chaff, etc., is often necessary to induce Burmans to grant consent. With them in my opinion the chief obstacle is laziness; they hate bringing their cattle, waiting their turn or giving a hand. If the job can be done while they sit around and smoke they don't mind. With Indians the case is quite different. They do not wish to have anything done, or be interfered with.

"When cattle are injected it is usually hopeless getting owners to mix their cattle with sick ones; they prefer to take their chance of animals contracting disease later. We have injected many animals two or three times owing to fresh cases being introduced, but, generally speaking, one injection is all owners will submit their cattle to."

There was a very marked improvement in the working of the segregation rules in Amherst and the benefits derived therefrom were better understood. As might be expected, in some districts villagers take to them more quickly than others. The report emphasizes the necessity, in the direct interest of Burman cattle-owners, of some action in the way of effective control of the badly managed herds of cattle kept by Indians in Burma, as all their methods help the spread of infectious disease among cattle.

Central Provinces. Mr. C. W. Wilson held charge of the department throughout the year. The post of Second Superintendent was vacant. Fourteen Inspectors and Assistants were on military duty. The total mortality from contagious diseases was reported to be 24,380 against 19,894 in the previous year. Of these, rinderpest alone accounted for 13,420 deaths, while hæmorrhagic septicæmia was responsible for 5,270 deaths. An

extensive outbreak of surra again occurred throughout the province, entailing a loss of nearly 542 equines.

It is gratifying to note that the department is gaining, more and more, the confidence of the people. In two years the number of cases treated by Veterinary Assistants has risen from 2,67,676 to 4,44,104.

Cattle-breeding farms continued to be run by the Agricultural Department working in co-operation with the Veterinary Department. The educational work done by the latter was confined as usual to lectures and demonstrations given at a few of the more important Agricultural Shows and at meetings of Agricultural Associations. It is proposed to prepare a series of bulletins in a popular style on stock-breeding and cattle diseases. The necessity for this form of propaganda cannot be sufficiently emphasized. The Agricultural Department is rapidly increasing the number of cattle farms under its control, and unless there is a corresponding increase in knowledge and desire for progress among the people much of its work will be in vain. The distribution of improved stock, especially of good bulls, will fail to improve the cattle of the country to any appreciable extent unless the people understand the importance of careful breeding and are ready to undertake the steps which will lead to improvement.

Assam. Mr. W. Harris held charge of the department throughout the year. The subordinate staff was strengthened by the appointment of four new Assistants, bringing the total number to 41. The reported number of deaths from contagious diseases among cattle during the year under report was 60,710 against 47,932 in the previous year. These figures are more than double those of 1913-14 since when the deaths reported have increased year by year. The increase is attributable largely to improved reporting but also to the prevalence of rinderpest in all districts except the Naga Hills. This disease caused 29,808 deaths this year against 20,817 last year. The heaviest mortality was in the district of Goalpara where unfortunately in very few instances were reports of the outbreaks received in time for preventive inoculation to be undertaken. The Local Administration has drawn the special attention of

the veterinary and district officers to this. Foot-and-mouth disease, hæmorrhagic septicæmia and anthrax were responsible for 5,603, 5,525 and 2,748 deaths respectively. The increase in the number of deaths due to anthrax is not surprising considering the common procedure in the disposal of carcases. These are frequently left where the animals die, to be devoured by vultures and jackals, with the result that the soil becomes heavily infected. It cannot be too strongly urged that, in all cases of sudden death, the carcase should be buried deeply at once and should on no account be skinned or opened in any way. With a view to give the people some knowledge as to the prevention and control of cattle diseases, the "Manual of Cattle Diseases in India" by Colonel Walker, C.I.E., was translated into Assamese and a limited number of copies were distributed during the year.

The Superintendent remarks that, when circumstances permit, the question of sending a number of Veterinary Assistants to the College annually for a course of post-graduate training will have to be considered. Most of the Assistants are in isolated posts where they have little or no opportunity to keep their professional knowledge up to date and where they are inclined to forget much which is essential. The Chief Commissioner recognizes the desirability of such a course and has called for a definite scheme to give effect to this suggestion.

North-West Frontier Province. On Mr. Meadows' services being placed at the disposal of the Army Department Mr. T. F. Quirke held charge of the department in addition to that of North Punjab. One-fourth of the sanctioned scale of the subordinate veterinary staff was on military duty. On account of abnormal rainfall the year was especially unhealthy. The total mortality from all contagious diseases was 2,904 as against 1,827 in the previous year. A serious outbreak of surra occurred during the year, but the disease was prevented from spreading by the destruction of confirmed cases and by the adoption of suitable measures for the disposal of the carcases. Among cattle diseases rinderpest claimed about treble the number of last year's victims and foot-and-mouth disease was unusually prevalent owing to the wetness of the weather. The Superin-

tendent remarks that much less difficulty is now experienced in dealing with outbreaks effectively as the benefits of inoculation are more generally understood, animals being readily brought forward for inoculation.

Sind, Rajputana and Baluchistan. Mr. J. A. G. Cattell held the post of Superintendent throughout the year, except for 13 days in March when he proceeded to Quetta for training in the Army Remount Department, Baluchistan Circle, and Khan Bahadur S. G. Haji, Deputy Superintendent, acted for him.

Sind.—The subordinate staff consisted of 16 Assistants. The total mortality during the year was 5,686 against 3,326 in the previous year. The increase was chiefly due to the wider prevalence of parasitic gastritis among sheep and goats, rinderpest, hæmorrhagic septicæmia, contagious pleuro-pneumonia among goats, and surra.

Baluchistan.—The subordinate staff consisted of four Veterinary Assistants.

The total number of deaths reported was 9,286 against 16,619 in the previous year. Of these 8,775 sheep and goats died of anthrax, scabs and wireworm.

Proposals for the creation of a separate Superintendentship for Baluchistan, and for the expansion of the department, have been submitted to Government.

Rajputana.—The subordinate establishment consisted of three Assistants as in the previous year. There are only two veterinary hospitals in the province, one at Ajmer and the other at Beawar. Mr. Cattell reports that the Assistants at Ajmer and Beawar are not under sufficient professional supervision as his duties in Sind and Baluchistan have increased enormously. It is, therefore, suggested that the expansion of the department in British Rajputana, and the question of proper supervision, may be taken up at an early date.

Imperial Bacteriological Laboratory. During the year under review the output of the products of this laboratory was increased to nearly double that of last year.

To meet the increasing demands for anti-rinderpest serum and to maintain rinderpest virus for use in the inoculation of

animals at the military dairies, the branch laboratory at Bareilly was opened during the winter months and 404,847 doses were prepared there. During the year the demand for mallein from the Military Department increased enormously, but all indents were complied with.

The following table compares the amounts of the various sera and vaccines manufactured at this laboratory and issued during the year 1917-18 with the average amounts of the preceding five years.

Name of product	Doses prepared		Doses issued.	
	1917-18	Average of previous 5 years	1917-18	Average of previous 5 years
Rinderpest serum . .	2,146,421	1,069,030	2,069,961	1,127,540
Anthrax serum . .	14,175*	21,623	19,727	25,020
Hæmorrhagic Septicæmia serum.	216,457	85,287	189,428	84,311
Hæmorrhagic Septicæmia vaccine.	117,124	127,890	117,124	127,890
Blackquarter vaccine .	...*	10,000	17,324	16,700
Mallein . . .	191,747	25,672	193,147	26,323

* Prepared according to demand.

Note.—The apparent discrepancies in the average doses issued and prepared during the previous five years are due to the fact that the opening balances of the first year of the period were unusually large.

The total value of the different products calculated on the basis fixed by Government amounted to Rs. 4,15,080 against an expenditure of Rs. 3,36,481.

Besides serving the needs of India, this laboratory undertook to meet the request of (1) the Ministry of Agriculture, Cairo, for a supply every month of 50,000 doses of anti-rinderpest serum up to December, 1918, and (2) of the Veterinary Department of the Soudan, for 200,000 doses of anti-rinderpest serum to be supplied before September, 1918.

During the year one Laboratory Assistant from Bengal, and a Veterinary Assistant from Kashmir, underwent a course of training at this laboratory.

For statistical information regarding the number of veterinary dispensaries and hospitals, inoculations performed in the various provinces, etc., reference should be made to Appendix IV.

2. Preventive Inoculation and Legislation.

A comparison of the figures of mortality among cattle in India from rinderpest alone during the last three years, *viz.*—

Year	Deaths
1915-16	95,159
1916-17	1,15,548
1917-18	1,43,861

indicates that the ravages of rinderpest are on the increase and, even allowing for the fact that the improved system of reporting outbreaks now in vogue has resulted in a large increase in the number of deaths notified, it is permissible to enquire how it is that in spite of the increasing number of inoculations performed we are unable to stamp out the disease or minimize its ravages. The greatest difficulty in this direction is the apathy, stubbornness and ignorance of the villagers. They do not sufficiently understand the contagious nature of the disease and the ruinous results which follow from their neglect of ordinary precautions. They have not yet grasped how much isolation and disinfection help to check the disease. Further, the unrestricted movements of animals from infected areas and absence of compulsory inoculation of all cattle in the affected village and those surrounding it, are the causes most responsible for the spread of the disease. In this connection it would be well to emphasize the fact that rinderpest is a disease which *can* be stamped out and prevented from again occurring in any district, if proper veterinary police methods are employed, the reason being that the virus which causes the disease is propagated almost exclusively in the bodies of ruminants.

There is no such thing as a spontaneous outbreak, because it can always be proved that the disease is at the time prevalent

somewhere in the neighbourhood and that it has been brought to the affected village either by animals suffering from the disease or by infected material. Among the principal methods by which cattle can be protected from rinderpest are (1) the serum alone method, (2) serum and simultaneous method, (3) isolation and disinfection, and (4) inoculation with bile. The first method has been accepted as the best for India on account of its simplicity and absolute safety, and consists in the injection of a suitable dose of serum calculated according to the body weight and susceptibility of the animal. The injection of this dose of serum does not give full protection for an unlimited length of time and is used with the object of raising the power of resistance of the animals which are exposed to infection, by neutralizing the causal agent, so that if they are attacked during the period of immunity they get only a mild form of the disease and become after recovery totally immune for life. If, on the other hand, the temporarily immunized animals do not get a mild attack of rinderpest at the time of inoculation, they are as liable as ever to future attacks. In consequence it may be necessary to reinoculate, if the disease has not died out in the villages. The serum alone method should always be used with powers of compulsory inoculation and isolation. In order that its application in the field may be effective, all animals must be inoculated at the same time both in the affected village and in the villages in the neighbourhood, so that the site of the outbreak of the disease may be surrounded and isolated by a barrage of immunized animals, and, by the time the immunity conferred on them by the serum has disappeared, the disease will have also died out from lack of a suitable host.

This was the plan of campaign employed in South Africa, together with the simultaneous method, to stamp out the disease there. Power was placed in the hands of the controlling authority to inoculate and isolate all animals compulsorily, and the ignorance and prejudice of one owner was not allowed to endanger the stock of the neighbourhood. By these means South Africa was freed from a devastating scourge.

It has not yet been possible to control thoroughly the disease in India for the following reasons: inoculation is not compul-

sory in affected villages and in villages close by, movements of animals in affected areas are not restricted, and it is also difficult to enforce proper methods of disinfection.

The Superintendent, Civil Veterinary Department, Madras, writes as follows :—

" After an extended trial in this Presidency, it must be admitted that the ' serum alone ' method of inoculation will not stamp out rinderpest in this country, while the conditions under which it has to be used in the villages remain as they are.

" Nothing less than compulsory inoculation will give the serum a fair chance, for, in a typical village, rarely as many as two-thirds of the cattle are produced for inoculation, and although the staff has been instructed repeatedly to return to every village for purposes of re-inoculating those animals which have already been done, the ryots get tired of producing them once a month, and when the animals eventually contract the disease from some of the uninoculated ones, and perhaps die, the serum is blamed.

" The result may be that eventually the ryots of that and other adjacent villages lose faith in the serum, refuse inoculation and re-inoculation altogether, and the disease goes on as if this department had made no effort at all in the matter."

It appears, therefore, that if legislation cannot be undertaken in the present conditions in this country, the question whether the simultaneous method cannot be adopted requires to be seriously considered, because there is not the least doubt that, with the increase in the facilities for transport of cattle by rail and road, the infection will be constantly on the move and will appear where least expected.

During the year under report Mr. Shilston and the Muktesar staff inoculated 1,498 animals at the various military dairy farms—Ayrshires, half-breds, country cattle and buffaloes—out of which only 8 died and these had rinderpest and foot-and-mouth disease at the same time. This indicates that, under proper supervision and with adequate staff, this method is of the greatest value, especially as the immunity afforded to the inoculated stock is of a permanent nature. It is true that it is not suitable for cattle over four months in calf and cows in milk, but, if sufficient staff is provided, it should be possible to consider-

ably alter the present state of affairs for the better by beginning with the cattle on departmental farms, planters' estates, and with the herds of large Indian owners. Once this method is adopted in a particular tract and care is taken to inoculate the young stock each year, there is no fear as regards future outbreaks in the tract though an occasional sporadic case may occur in an imported animal. The department will then be able to concentrate its attention on other diseases like hæmorrhagic septicæmia, foot-and-mouth diease, anthrax, surra, etc. Methods of isolation and disinfection should always be combined with methods of preventive inoculation as early as possible; if not, sooner or later, they are liable to break down.

The bile method is not suitable for conditions in India.

The main thing to remember in dealing with attacks of rinderpest among dairy herds containing highly susceptible animals such as half-breds, is that the disease, after passage through a highly susceptible animal, such as a half-bred, attains a much higher virulence, and the doses of serum for the rest of the herd should be increased accordingly.

There is much scope for preventive inoculation against hæmorrhagic septicæmia. Owing to its shorter course and usually greater virulence ryots are better able to appreciate the value of a protective serum in this case than in the case of rinderpest.

In connection with surra also the necessity for legislation is pointed out by Mr. Oliver, Superintendent, Civil Veterinary Department, United Provinces, in the following passage:—

"The spread of surra from its endemic areas in the tracts along the foot of the hills to the districts of Etawah, Mainpuri, Banda and Nainital, was due to the unusually extensive transport operations and frequent movements of animals during the past two years. In addition to these causes we must consider the yearly increasing facilities for travel and development of commercial intercourse between distant parts of the country, and it is easy to foresee a still further spread of infection unless energetic prophylactic measures are introduced without further loss of time. Whatever line of action is contemplated it is all important that the preventive measures taken must be swift and thorough. I am strongly of opinion that if we are to avert such

a catastrophe as that which occurred in Mauritius in 1902-03, more effective legislation than at present exists should be introduced at once. In 1910, it was decided that, with certain modifications and at the discretion of Local Administrations, the Glanders and Farcy Act could be applied in cases of surra, but although this was introduced in the case of the United Provinces, in some of the adjacent territories and provinces no active steps in this direction were taken. It is obvious that compulsory slaughter of all diseased animals, and isolation of suspected cases and 'in contacts' is one of the first and most important measures to be adopted, but if this rule is only enforced here and there the result cannot be anything but a costly failure. The Surra Act or a modified or amended form of it should be applied without exception throughout the whole of India. Next in importance to the destruction of all affected cases is the more complete control of the movements of all animals in the diseased localities, and powers should be acquired to declare affected areas, and, where necessary, to prohibit ingress and egress to and from such places. Rules for the closing of fairs and the prohibition of animal traffic on certain highways, if desirable, might be considered."

In this as in many other diseases the increase in the spread of infection has become very marked and it is most important that similar methods of control should be adopted throughout all India. A policy of control confined to a district or a province is a policy of half measures at which the disease will laugh.

3. Cattle-breeding.

The improvement of cattle is a matter linked closely with the public interest throughout India and as such is steadily attracting increased attention. The prices of working and milch cattle have of late years been rapidly rising. Valuable indigenous breeds are dying out and rapidly losing their essential characteristics through indiscriminate and careless methods of breeding, while a heavy drain is caused by the best stock being constantly sold out of the district. Good milch cattle are absorbed in large towns where they are badly handled and not utilized to the best advantage. The cattle-breeding industry in this country in the past has been carried out to a large extent in

definite grazing tracts by nomadic tribes, and the cultivators in most parts have relied upon them for their supplies. The extension of arable cultivation which is ever encroaching on these breeding areas, and an increased demand for plough cattle, combined with other causes, have brought about what is rapidly becoming a serious shortage of cattle. It is now generally recognized that this deficiency will have to be met by breeding in arable tracts. In these areas it will necessarily be costly owing to the competition of commercial crops like cotton, jute, etc., all of which carry such high returns that in many districts it pays to buy cattle rather than breed them. Once, however, cow-keeping could be made profitable there would be a large number of young male stock available for draught purposes. The supply of plough cattle would then be ensured together with the establishment of cow-keeping as an industry. Our aim should, therefore, be to maintain and foster by careful breeding and selection good dual purpose breeds (like Hansi-Hissar and Sindhi), wherever these are already available. In localities where no such fixed breeds exist, our endeavour should be to introduce outside strains of blood with the object of gradually fixing an improved type of cattle by a careful process of selection and grading up. In such cases it would be best to maintain two herds, one of selected local cattle and the other of local cattle crossed with a suitable strain from outside, so that it would be possible to judge after a few years which line of work was most suitable for the particular requirements of the district.

As far as possible Government cattle farms should be located in the breeding tracts so as to influence the breeders in the vicinity.

In non-breeding tracts the increasing cultivation of crops like cotton and jute has led to a decrease in the cultivation of fodder crops. This is a serious state of affairs as the question of stock feeding does not form an essential link in the chain of farming operations in India, as it does in England, and, therefore, there is no essential rotation including a crop, like roots, which in England automatically provides for a certain percentage of the land being devoted to cattle feeding crops each year. As the average Indian cultivator relies on odds and ends for cattle food and makes next to no provision for his cattle from

his own cultivation, the year after a famine finds him without any cattle to plough with, in which case his land is just about as much use to him as a watch without works. Until it is realized that land set apart for cattle fodder is a form of insurance against total loss, the old system will go on. The position in some parts of India, notably the Bombay Presidency, has been such that, before any project in the direction of improving the quality or increasing the number of cattle can be carried out, efforts must be made to ensure an adequate supply of fodder. In such parts the question largely turns on how to maintain a sufficient supply to prevent the great loss of cattle in famine years.

The problem of cattle-breeding, therefore, requires to be attacked simultaneously from various sides, *e.g.*—

(1) The opening of farms for (*i*) preserving the purity of good breeds, (*ii*) supply of good bulls, (*iii*) building up a pedigree herd of good milking strain, (*iv*) cross-breeding with suitable imported breeds, and (*v*) demonstration of scientific methods of breeding.

(2) Increase in the supply of fodder where it is deficient, prevention of waste and its utilization to the best advantage where there is a surplus.

(3) Appointment of whole time officers who would devote themselves entirely to these problems.

With regard to this last, it is not generally realized that cattle-breeding is a distinct science apart from either agricultural or veterinary work. A man may have received a first class agricultural or veterinary training, but it does not follow that he will be any use in dealing with stock-breeding problems. An "eye for a good one" coupled with long experience are the criterions for success in this line of work in England where it has been proved again and again that all the training in the world is useless without this natural gift.

But not only are breeding farms to be supervised, the public must be educated as to the care to be taken in the selection of cows, the weeding out of undesirable and worthless stock, and proper feeding of both the parents and the young stock. India at present is an easy first in determining the minimum ration on which an animal can drag through life, but with regard to an

efficient ration for milch and plough cattle no country has more to learn, and the work of ascertaining the proper balanced rations for all kinds of stock is a matter of supreme importance.

We shall now proceed to review the work done in the various provinces.

In Bombay, the new scheme for issuing premium bulls mentioned in last year's report was introduced on a modest scale and a few bulls have been distributed. Sites for the proposed cattle farms are being selected in the Deccan. The cattle-breeding farm at Tegur, Dharwar, under the local Agricultural Department, is making good progress, while in Gujarat the Northcote Cattle Farm at Chharodi, Ahmedabad District, started with a view especially to prevent the famous Kankreji breed of cattle from being extinguished, has been doing valuable work. It was mentioned in last year's report that the cows at Chharodi mature very late and only a few calve before six years of age. The question of getting heifers to come in season earlier is engaging attention. There are indications that it is a matter in which feeding plays a considerable part.

In Madras, cattle-breeding operations are controlled by the Deputy Director for Liverstock. This officer has issued a report on the Madras town milk trade in which he shows clearly that this trade is in a bankrupt condition and subsists on adulteration. To put it on a sound basis the first thing is to evolve a dairy cow that will pay for its keep and in addition provide a profit for its owner. This means a cow producing much more milk than is produced by any of the local breeds.

This officer has been paying attention to the need for improving the buffalo which supplies most of the *ghee* (clarified butter) and butter consumed in the Presidency. A beginning will be made at breeding good bulls in the Circars where they are now conspicuous by their absence. A number of bull calves from good milkers are being purchased and will be reared at Samalkota and Anakapalle.

A cattle-breeding farm for Ongole cattle has been opened in Nellore District.

At the Coimbatore College Dairy, a number of half-bred dairy cattle were purchased. During the year there were two

outbreaks of rinderpest. In the first there were no casualties, but in the second attack, which was more severe, a large number of cattle succumbed in spite of prompt inoculation by the " serum alone " method. It may be remarked that half-bred cattle should be inoculated by the simultaneous method and that the " serum alone " method is practically valueless in the case of such cattle.

In Bengal, cattle-breeding operations are being carried on at Rangpur under the supervision of the Agricultural Department. The stock consists of two distinct herds, one of Bengal bred cattle and the other of Bengal cows crossed by a Hansi bull. The number of cows has been tentatively fixed at 100. The cows are now more or less of a type. Since the change of bulls 18 months ago on the re-organization of this farm, the progeny bred are greatly in advance of any previously produced.

In Bihar, cattle-breeding operations are being conducted at Sipaya. The intention is primarily to breed for draught purposes, but an endeavour is also being made to produce a dual purpose animal suitable for both draught and milk. A certain amount of attention is also paid to the improvement of the local milch buffalo by the importation of a limited number of bulls and cows of the celebrated Rohtak, Delhi and Hissar milking strains.

The Sipaya farm is intended to further the improvement and prevent the degeneration of cattle in North and South Bihar. The other two tracts, *viz.*, Chota Nagpur and Orissa, differ from Bihar, in almost all particulars, and the type of bull that is being reared at Sipaya cannot be usefully introduced into Chota Nagpur or into Orissa in the present agricultural conditions obtaining in these areas, which are unfavourable to cattle-breeding. The question of these tracts is, however, receiving attention.

In the United Provinces, there are two Government farms, one at Manjhra, in the Kheri District, and the other at Madhurikund in the Muttra District. The former district has long been famous for its breeds of cattle, *viz.*, Kherigarh and Parehar. The farm has been opened with a view to check the diminution in the numbers of these breeds. They are not good milkers but good draught animals, and are much in request in Oudh and Northern Bengal in the rice-growing tracts.

The farm at Madhurikund deals with another class of animal. There has arisen a strong demand in many parts of the United Provinces for a moderately large-sized working bullock and a better milch cow. Unfortunately, with the exception of the Mewati or Kosi strains, there are no special breeds of cattle indigenous to these provinces which combine both these qualities. Experiments with crossing the ordinary *desi* cow of good stamp with the Hissar, Sahiwal and Kosi strains are in progress. Breeding of good Murrah buffaloes for herd purposes is also being done. Experiments in crossing with imported Shorthorn cattle are being carried out. The first draft of sires was sent out three years ago and 67 have up to now been provided.

The Punjab can boast of having at Hissar the largest cattle farm in India. It has done exceptionally good work for the province and adjoining tracts. The total number of animals on the farm on the 31st March, 1918, was 5,567, valued at Rs. 5,30,000. It issued 206 Hissar bulls to the District Boards. Eleven bulls and 110 heifers were sent to Java, and 100 cows at Rs. 300 each were sold to a representative of the Brazilian Government. The great demand for the bulls is a testimony to the superior quality of the stock.

In the North-West Frontier Province, the young stock of the Awankari herd at the Agricultural Station, Tarnab, have grown into very promising animals. It is hoped that in a short time it will be possible to increase the number of cows in the herd and that suitable bulls for District Boards will be available for issue shortly.

The Agricultural Department in the Central Provinces is making rapid progress in cattle-breeding. The dairy farm at Telinkheri maintains dairy herds both for Government and for the *gaolies* of the two Co-operative Dairy Societies. The bulls used include an Ayrshire, one Montgomery, one Montgomery-Hissar cross and three Delhi buffalo bulls. The cross between the Montgomery and Gaolo breeds has proved a very useful draught animal, being well shaped, strong and tractable. The Ayrshire-Gaolo cross is not so promising. The Government buffaloes of the Delhi breed continue to give larger yields of milk than those of local breeds, the average yield of the former

being 2,500 lb. and of the latter 1,954 lb. for the year. All the young buffaloes now being reared on the farm are either pure Delhis or crosses between the Delhi and local breeds. With a view to obtain cheaper grazing and more land, a farm has been opened on the Raigarh plateau of the Balaghat District where conditions for cattle-breeding are ideal.

With a view to improve the breed of Chhattisgarhi cattle which are very poor and by their weakness handicap the adoption of improvements in the general standard of cultivation, the Agricultural Department started the Chandkhuri cattle-breeding farm five years ago. In the year under report the herd of cows here has been almost doubled. Similar breeding farms have been opened this year for the improvement of the Chhattisgarhi breed in the other two districts of the division, *viz.*, Bilaspur and Drug. In two or three years the department hopes to be able to supply from the three farms 40 to 50 bulls every year to private cattle-breeders in the Division. A large number of Malguzars have expressed their willingness to purchase bulls from the Government farms, and have agreed to get all the inferior bulls of their villages castrated.

A new cattle-breeding farm was opened as an adjunct to the Sindewahi Experimental Farm. The breed selected for this farm is the Umardha from the adjoining district of Yeotmal. The animals of this breed being strong, active and of medium size, should do well for the rice tract.

Cattle-breeding operations are also going on at Powarkhera and Adhartal with the Malvi breed—a breed typical of the wheat tract.

In Assam, there is a cattle farm at Upper Shillong. As regards the general question of the improvement of local breeds of cattle, it has been decided to wait and see the results of the experiments being carried out at Rangpur, and the Government of Bengal have been asked whether they will be able to supply Assam with a few bulls for breeding purposes from this farm.

At Pusa, important work in connection with cross-breeding is in progress. Two distinct herds are maintained :—

(1) Pure Montgomery herd.
(2) Cross-bred Montgomery × Ayrshire herd.

In the former herd a rigorous policy of selection for milk yield is being carried on, and no cow is being kept on in the milch herd that does not show signs of coming up to the standard. The results of the cross-breeding work up to date are very favourable.

The half-dozen cross-bred heifers got by the first Ayrshire bull introduced have grown into good type cows, taking in the majority of cases more after their sire (Ayrshire) than their dam (Montgomery).

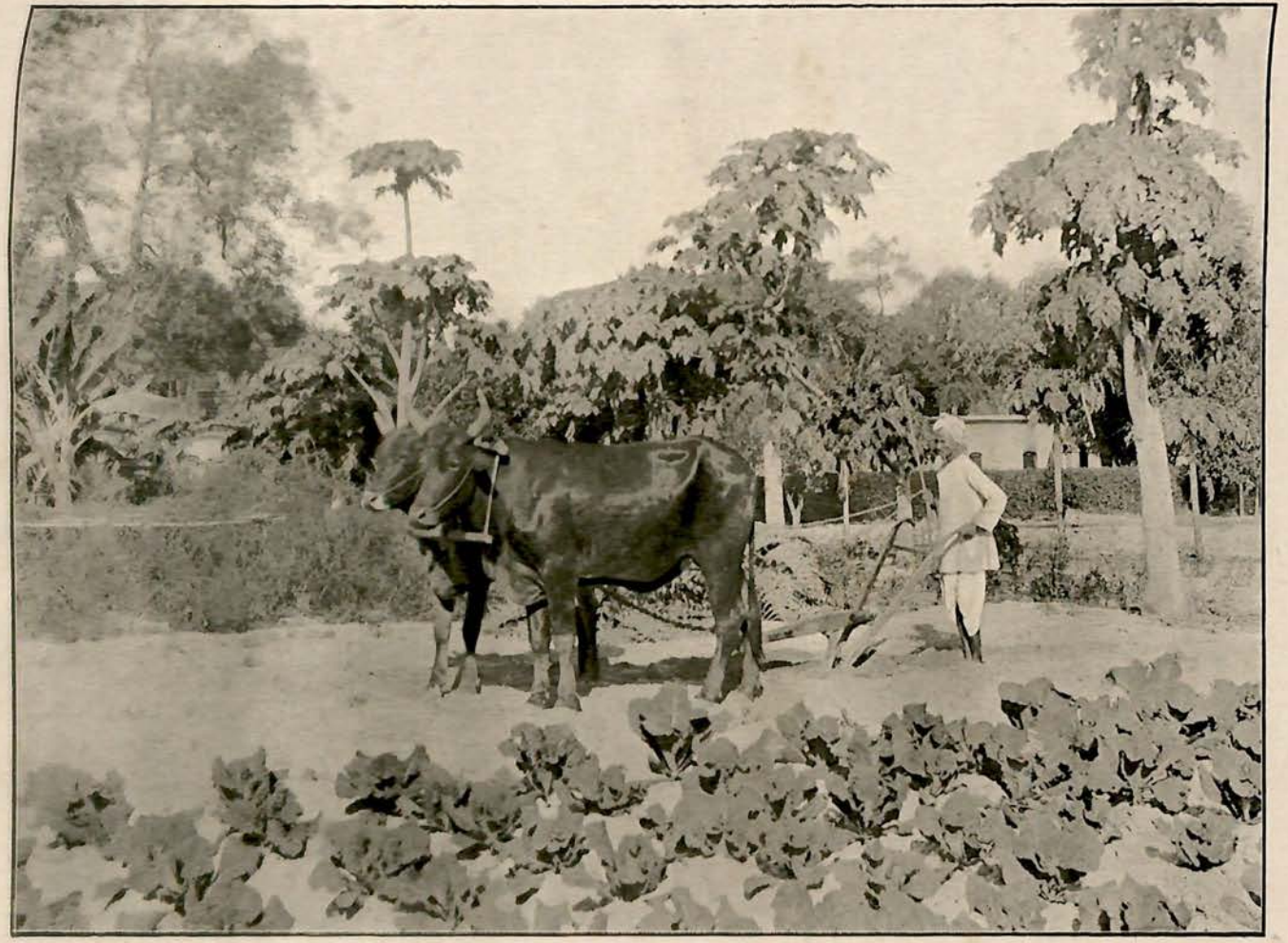
One of these cross-breds has given over 7,000 lb. milk in a lactation period of 10 months—nearly double the quantity yielded by a good Montgomery cow—and the other five have given yields varying from 4,000-6,000 lb. These cross-bred heifers have been found to be free from the Montgomery tendency to stand off for a considerable period after calving. They all came back to bull in one to three months. This is a great point in favour of cross-breds so far as successful dairy farming is concerned, as the maintenance of a large number of empty dry cows is one of the greatest handicaps to successful dairy farming with the indigenous cow. The weaning of their calves at birth in the case of these cross-breds had absolutely no effect on their milk yield. It is proposed to start this year putting half-bred heifers to half-bred bulls, and it will be interesting to see whether after this cross the calves can still be weaned at birth.

The castrated bullocks of the Ayrshire-Montgomery cross have also proved good workers.

Pusa is now able to supply good stock to cattle-breeders and zamindars. A sale of surplus stock was held in March when the 53 head offered were very keenly bid for and realized Rs. 5,600. All the young stock have now been inoculated against rinderpest by the serum simultaneous method. The cross-bred bull calves sold at subsequent auctions can thus go out into the district without risk. The ever present risk of having years of work on the cross-bred herd wiped out in one attack will be removed.

4. Sheep-breeding.

Sheep-breeding experiments have been undertaken in several provinces with a view to improve the quality and increase the



CROSS-BRED AYRSHIRE-MONTGOMERY BULLOCKS AT THE PLOUGH.

PLATE IV.

quantity of wool of the indigenous sheep. Considerable difficulties have to be overcome in carrying out sheep-breeding successfully on improved lines. Among these is the fact that the type of sheep which we are in some cases endeavouring to breed in India is the combination of a good fleece and a good carcase which is accepted as the most useful sheep in England. The climate of India, however, is dead against the possibility of any animal with a deep fleece carrying a fat carcase, and the indigenous sheep, which is practically a hairy greyhound, shows plainly what we may expect any cross-breeding of this kind to degenerate into. The goat will fatten and the sheep will carry a fleece, and any attempt to combine these qualities in the same animal is doomed to failure, except in certain favoured localities, and much time and money will be saved if this fact is accepted as of general application. Another difficulty is the heavy mortality among the imported stock owing to change of climate and the prevalence of epizootic and parasitic diseases to which they are exposed in this country. Even the indigenous stock are not altogether immune to these scourges. It is hoped, however, that, as a result of crossing, the graded up progeny will acquire from the native parent or grandparent a degree of immunity to the effects of the climate and to certain of the most dangerous sheep diseases. But here again the fact that the influence of the imported parent may predispose the progeny to diseases from which the indigenous sheep has never suffered, is possibly the explanation for the sudden appearance of sheep diseases hitherto unknown in India among stock bred in the country.

The proper handling of sheep and wool, including careful methods of shearing, dipping and packing of fleeces, etc., is practically unknown to Indian shepherds. The condition in which wool is turned out makes a considerable difference to its value in the market. It will thus be seen that the operations of the department in this direction are of considerable importance to the future of the woollen industry in this country.

The progress made in the various provinces may now be noticed.

In Madras, a combined sheep and seed farm has been opened at Bantanahal. Experiments on the Bellary breed, which is a

very mixed one, were begun in 1911 and 1912 with a view to establish, if possible, a black-faced, white-woolled breed. A typical flock of the Bellary breed consists almost entirely of woolled animals, only one or two, if any, hairy sheep being present. Among the woolled animals the following types are to be found :—(1) all black, (2) all black except for a white blaze on the forehead, (3) piebald (black and white), (4) blackfaced (white body with black on face, feet, etc.), (5) white-faced, all white, both body and face.

The first three types make up the bulk of the flock, the last type is not common. So far the results of mating point to the correctness of the theory that the black-faced type is a heterozygote and that the black and the white types are pure. This theory will be further tested at Bantanahal where the flock will be increased as the farm is developed and an attempt made to establish some economic breeds. The problem is important commercially for, though all black wool brings the best price, grey wool, to which colour the fleece of the black sheep turns after the second shearing, fetches a lower price than white.

In the Central Provinces, sheep-breeding experiments are being conducted at Telinkheri with a view to ascertain whether it is possible to increase the quantity and improve the quality of the wool of the flock by crossing the ewes with half-bred Merino rams. Seventy-three crosses have been obtained up to date. These have given more wool and the staple too is longer and finer.

In the United Provinces, experiments with sheep continue to be very encouraging and highly satisfactory. A further batch of 12 Merino rams was imported from Australia this year and will shortly be put to stud work. A great demand for the half-bred male stock for introduction into native flocks is beginning to arise; 60 young rams have already been issued and indents for a further 40 have been received. The original proposal to establish a sheep farm near Orai has for the present been abandoned owing to shortage of staff, but a strip of land is being acquired adjacent to the Muttra cattle farm where the sheep run will temporarily be maintained under the direct observation of the farm officials. The introduction of the Merino strain has

been found to improve steadily the fleeces in point of weight and all round richness. Experimental flocks of selected ewes are located at Lucknow, Moradabad, Kheri, Muttra, Etawah and in Bundelkhand. The results of experiments with the dipping of sheep have proved that, in India as in other countries, judicious and periodical dipping is of immense benefit to the fleece as well as to the general health of the sheep.

In the Punjab, sheep-breeding experiments are in progress on the Hissar farm. The total number of sheep there on 1st April, 1917, was 1,138. These include country-bred, cross-bred and Merinos. Sheep seem to suffer more from abnormal rains than any other stock-chiefly owing to maggot infection. Parasitic gastritis which gave some trouble was kept in check by drenching the flocks with copper sulphate and mustard. With a view to prevent very heavy casualties among lambs born in the cold weather, an interesting experiment was made. The rams were taken out of the flocks at the end of the cold weather and put back in October. The experiment looks like being successful as no casualties have taken place among the lambs born in March and thereafter. The half-bred and three-quarter bred wool fetched good prices and was very favourably reported on by the Cawnpore Woollen Mills Limited. One hundred and eleven rams and ewes were sold during the year for breeding purposes.

In the North-West Frontier Province, operations in this line are being carried out on a small scale in the Hazara District.

At Pusa, the sheep-breeding experiments were continued during the year under report. As soon as conditions regarding importation improve, two new Merino rams will have to be procured for the flock as much in-breeding is now going on for want of fresh blood.

It is necessary to emphasize that great care is required in the management of imported rams in this country. Failure in this respect led to the death of all the four Merino rams imported from Australia for crossing the indigenous ewes in the Porbandar State. They apparently came through their first tupping season in the spring very well, but the summer heat

proved very trying and they all succumbed during the autumn to some form of lung disease contracted during the monsoon.

5. Veterinary Education.

For the training of students there are Veterinary Colleges at Bombay, Madras, Calcutta and Lahore, and Veterinary Schools at Insein and Taunnggyi in Burma. The standard up to which the Bombay, Bengal and Madras colleges teach is more or less uniform. In these three colleges tuition is conducted through the medium of English, while in the rest it is in the vernacular. A glance at Appendix V will show the main results of the working of the different colleges and schools during the year under report.

In many of the colleges farriers and dressers were also trained for service with the Army. The Principal of the Madras College also held a class for veterinary compounders which was attended by seven men. At the Insein School two Veterinary Assistants were under training for appointment as Veterinary Inspectors and one Veterinary Inspector for appointment as Deputy Superintendent. In accordance with the suggestion of Colonel Evans to send Assistants of the Southern Shan States in turn to Insein for practical training, six Veterinary Assistants were deputed by the Superintendent and Political Officer of these States.

There is a great demand for Veterinary Assistants in the various Provincial Departments, the Army and Indian States. The existing colleges with the present limited staff and accommodation are unable to fully meet this demand. The increased pay and improved prospects now available in the Army Remount and the Army Transport Departments, and the sanctioning of a Subordinate Indian Veterinary Department for the Army, will still further increase the demand for graduates, and the pressure especially on the Punjab College, already great, will still further increase. One more college at least is urgently needed in Northern India, located either at Lucknow or Allahabad, to provide for the wants of the Hindi-speaking population. Complaints are numerous that the quality of the recruits is unsatisfactory, and it is agreed that, unless the prospects of pay and

promotion are improved, it cannot be expected that men with higher educational qualifications will be forthcoming. All these matters, together with the question whether it is advisable to have a special higher grade college or possible to raise the standard at one or more selected colleges so as to turn out students who will be qualified for appointment to the higher grades of the Provincial Service, or ultimately to the Imperial Service, (as recommended by the Public Services Commission in paragraph 7, annexure II, page 79 of volume 1 of their report), are under the consideration of the Government of India. It is clear that, if the status of the Veterinary Department is to be improved, the question of veterinary education must be seriously considered, especially if it is proposed to provide a training which will qualify Indians for admission to the Indian Civil Veterinary Department.

6. Veterinary Research.

The amount of research work done during the year was not large, owing to the paucity of staff tnd increase in routine and administrative duties of those who were left to carry on.

Rinderpest. The question of the vitality of the virus of rinderpest under varying conditions is still under investigation at Muktesar, and a special series of experiments is being carried out with the object of ascertaining the length of time for which hides removed from animals which have died of rinderpest remain infective.

Dourine. The diagnosis of dourine (the disease which has been giving so much trouble in the horse-breeding districts in the Punjab and Baluchistan) by the complement fixation test was continued, and there is every hope that it will be possible by this means to detect latent cases of the disease and so prevent its spread, as such animals though showing no visible symptoms may transmit the infection to healthy stock.

Anthrax and Hæmorrhagic Septicæmia. The modifications in the manufacture of these sera foreshadowed in last year's report of the Imperial Bacteriologist, Muktesar, have been effected, and have resulted in a very distinct reduction in the mortality among the serum-making animals, and also in a saving

of labour. The question as to the length of time hides from animals which have died of hæmorrhagic septicæmia remain infective is also under investigation.

In the Central Provinces, sufficient evidence has been obtained to implicate pigs as transmitters of hæmorrhagic septicæmia among cattle.

Contagious Abortion in Cattle. A number of attempts were made at Muktesar to isolate the organism responsible for this disease from pathological materials sent to the laboratory, but all failed owing to the presence of numerous contaminating organisms. A culture of the bacillus responsible for the disease in Europe was obtained through the courtesy of Sir John McFadyean of the Royal Veterinary College. This strain is now kept running in the laboratory.

Up to the present the number of tests carried out is too small to warrant any definite opinion, but the results of these tests appear to indicate that the same bacillus is responsible for the disease in India.

Johnes' disease. In view of the detection of cases of this disease in India, a short account has been published in the *Agricultural Journal of India*, vol. XIII, part I. Two suspected animals were under observation at Muktesar but attempts to obtain cultures of the bacillus were unsuccessful. In two cases positive diagnosis has been arrived at. The materials in question were portions of the intestines and mesenteric glands from two animals at Poona, and they were sent for confirmatory examination by the Superintendent, Civil Veterinary Department, Bombay. As the specimens had been placed in preserving fluid, nothing beyond microscopic examination was possible.

Tuberculosis. A number of strains of tubercle bacilli have been isolated from bovine lesions and these are being studied at Muktesar.

Colonel Liston and Mr. Soparkar have carried on investigations into the susceptibility of Indian milch cattle to tuberculosis. Their experiments show that the comparative infrequency of tuberculosis among Indian cattle, whether buffaloes or bovines, is due to a natural resistance to infection rather than

to differences in methods of housing, etc. It has also been found that individual susceptibility varies more among Indian than among English cattle. The results have been published in the *Indian Journal of Medical Research*, vol. V, no. 1, July, 1917.

In the January, 1918, issue of the same Journal, Mr. George Taylor gives the results of his enquiry into the prevalence of bovine tuberculosis in the Punjab. His figures would appear to indicate that, at least as far as concerns the Punjab, tuberculosis is not as rare a disease among Indian cattle as has been thought. It is pointed out that up to the present all the cases of bovine tuberculosis in Indian cattle have been recorded in northern provinces. On the other hand, the absence of, or the limited nature of, inspection in other parts may explain to some extent the absence of records of the disease.

Surra. At the laboratory attached to the Punjab Veterinary College, the experimental treatment of surra with large doses of arsenious acid and tartar emetic has proved moderately successful, but the treatment is difficult and unwieldy and cannot be recommended for adoption in the districts. Unfortunately some cases improve considerably and keep good condition although still bearing the trypanosome in the blood. If care is not exercised such animals may prove a danger to others when flies are prevalent. Some experiments have been made by Mr. Taylor regarding the transmission of surra in the dog, and the results so far obtained go to prove that the disease is transmitted from the jackal to the dog by means of infected fleas, and that the fleas from an infected dog readily spread the disease to other dogs kept near it. No case of distant transmission by the dog flea has so far been noted, but experiments are being continued in this direction.

Some mortality from surra in cattle was again recorded in the Central Provinces. In two instances in bovines the parasite appeared to be of a new species judging from its morphological characters alone. But for want of experiment it is not possible to record any definite data bearing on this matter.

Miscellaneous. Colonel Liston detected schistosomiasis in cattle, sheep and goats at the Bandra Slaughter House. It is probable that the disease is widely prevalent and enquiries are

being instituted. The Provincial Veterinary Department and the Bacteriological Laboratory at Parel are collaborating.

Foot-rot among sheep was discovered for the first time this year in the Central Provinces.

Colonel Pease reports that the anti-rabic inoculation of dogs and horses has, so far as can be ascertained, proved successful, but decisive results have not yet been obtained.

CHAPTER VI.

PUBLICATIONS.

Imperial. The Imperial Department of Agriculture in India issued, during the year under report, 8 Memoirs, 11 Bulletins and 2 Indigo Publications (a special series started to embody the work of the recently created Indigo Section of the Pusa Institute.) During the year the proceedings of three conferences were published, *viz.*, the Board of Agriculture, the Second Entomological Meeting, and the First Mycological Meeting. An effort, which it is believed has been appreciated, has been made to make the form of publication of these proceedings more attractive.

The Report of the Proceedings of the Second Entomological Meeting held at Pusa in February, 1917, issued in an octavo volume of 340 pages forms practically an abstract of our current knowledge of Indian crop-pests.

The first edition of the bulletin on " New Agricultural Implements for India " ran out of stock within three months of its issue and a second edition was brought out. Another bulletin on " Berseem as a new Fodder Crop for India " was also reprinted during the year to meet the heavy demand. A large number of copies of the three bulletins regarding the diseases and feeding of camels issued during the year were supplied to the Army Department.

The *Agricultural Journal of India* in its new form is increasing in popularity. As in the previous two years, a Special Number of the Journal, containing a selection of papers on agriculture and allied subjects read at the annual session of the Indian Science Congress, was published.

Provincial. The Bombay Department has up-to-date issued 90 bulletins and 82 leaflets of which four and eight respectively were brought out during the year under report. The former dealt with such diverse subjects as utilization of inferior grass herbage, fruit culture, artificial manures, and the sugarcane work on the Manjri farm. *The Poona Agricultural College*

Magazine, and also the Marathi, Kanarese and Gujarati periodicals continued to be issued. A fourth vernacular magazine dealing with Konkan agriculture only was started during the year by a private individual with the assistance of the department. The value of such magazines in creating interest in agricultural improvement and in popularizing the work of the department cannot be too highly emphasized.

In Madras 9 leaflets were issued during the year. The Agricultural Calender was published in English and the four vernaculars of the Presidency and over 64,000 copies were distributed. Mr. Parnell and his assistants published a paper (*Memoirs, Department of Agriculture in India, Botanical Series*, vol. IX, no. 2) on the inheritance of characters in rice. A Memoir on the classification of Indian canes with special reference to the Saretha and Sunnabile groups was published by Dr. Barber. The Year Book for 1918, and a report by Mr. A. Carruth on the Madras dairy trade were also issued.

In Bengal three leaflets were issued during the year. One of these dealt with the question of cotton cultivation in Bengal, and the utilization of water hyacinth as a manure for its potash content formed the subject of another.

The Bihar and Orissa Department issued 3 bulletins during the year. Of these one on " Some Sugarcanes bred by the Government Sugarcane Expert, Coimbatore, and Considered likely to be Suitable for Bihar," may be particularly mentioned. The publication of the half-yearly Journal was suspended for the period of the war.

In the United Provinces a pamphlet on manures was published in English, Urdu and Hindi. Another on increasing the food supply was also issued. A revised pamphlet on agricultural improvements is in preparation. It is reported that the demand for vernacular pamphlets on agricultural matters of local importance ran into many thousands. Mr. G. Clarke published a paper on the preparation of plant neucleic acids in conjunction with Professor Schryver of the Imperial College of Science and Technology, London. Both the vernacular agricultural Journals, *Mufidul Mazraine* and *Kissen Upkarak*, continued to be issued and are widely appreciated.

In the Punjab, Mr. Milne has written an illustrated monograph on ear-cockle in wheat. The publication of his book on date-palms has been unfortunately delayed owing to some difficulty in getting illustrations. A departmental report on the sugarcane survey of the Rohtak District by Mr. Wilsdon is being prepared for the press.

Four leaflets were issued during the year in Burma. The results of Mr. Warth's enquiry into the prussic acid content of Burma beans were published as a Pusa Bulletin.

Only two leaflets, one on water hyacinth and the other on cotton in Assam were published, in the course of the year, by the Assam Department.

The *Agricultural and Co-operative Gazette* continued to be published in English, Hindi and Marathi in the Central Provinces. Leaflets on the cultivation of castor and sugarcane and on the use of green manures in rice cultivation were also issued. " A Scheme for Cattle-breeding in Chhattisgarh " was published and an Agricultural Reader is under preparation.

Among the publications issued by the Mysore Department during the year may be specially mentioned the bulletin on the " Cultivation of the Areca Palm in Mysore," " Proceedings of the Sandal Spike Conference held in October 1917," " Some Scale Insect Pests of Coffee in South India " and the Agricultural Calender for 1918.

The Travancore Department published 7 leaflets and prepared bulletins on (1) ordinary manures and (2) contagious diseases of cattle. The publication of the vernacular quarterly agricultural Journal was continued.

A complete list of agricultural publications issued in India during the year under report is given as Appendix VI.

CHAPTER VII.

EXPENDITURE.

The total expenditure incurred by the Imperial Department of Agriculture during the financial year 1917-18 was Rs. 5,81,723, as against Rs. 5,18,603 during the previous year. The details are given below :—

	Rs.
Office of the Agricultural adviser to the Government of India and Director of the Institute	2,34,865
Chemical Section	30,783
Mycological Section	46,964
Entomological Section	46,100
Pathological Entomological Section	22,493
Bacteriological Section	30,858
Botanical Section	46,203
Agricultural Section	64,577
Indigo Research Section	58,880
TOTAL	5,81,723

Out of the budget of this Department for 1917-18, a sum of Rs. 27,000 was placed at the disposal of the United Provinces Agricultural Department, against Rs. 13,620 in the previous year, for expenditure in connection with the continuance of the appointment of Mr. W. Hulme as Sugar Engineer in that province.

A sum of Rs. 15,000 was paid as a grant-in-aid to the Indian Tea Association.

The principal items of expenditure under the annual grant of Rs. 10,000 placed at the disposal of the Agricultural Adviser

to the Government of India for special agricultural experiments were as follows :—

	Rs.
Experimental cotton cultivation by the Imperial Cotton Specialist	1,250
Grant-in-aid to the Dairy Education Association, Indian Branch, for the Quarterly Journal of Dairying	510
Fittings and apparatus for the field laboratory of the Imperial Agricultural Bacteriologist .	1,999
Storage experiments by the Imperial Entomologist	434
Purchase of silk yarn	454
Grant to the Fibre Expert, for purchase of flax seed	1,453
Pay of a Veterinary Assistant in connection with cattle-breeding, a Fieldman for mosquito experiments, and an Assistant for pebrine work	1,903

The expenditure incurred in the working of the Imperial Bacteriological Laboratory at Muktesar during the financial year 1917-18 was Rs. 3,36,481 as against Rs. 2,67,128 in the previous year. The principal items of expenditure were as follows :—

	Rs.
Salaries and travelling allowances of officers and staff	95,024
Feed and upkeep of animals	1,23,018
Purchase of animals	51,359
Cost of chemicals and apparatus . . .	10,312
Other miscellaneous expenditure . . .	56,768*
TOTAL	3,36,481

* Inclusive of Rs. 7,592, charges for inoculation at the military dairy farms.

The total expenditure which the Provincial Departments of Agriculture incurred during the year under report amounted to Rs. 52,14,031 as against Rs. 47,74,524 during 1916-17. The details are shown below :—

	Rs.
Bombay	9,90,861*
Madras	7,76,336
Bengal	3,96,429†
Bihar and Orissa	3,63,900
United Provinces	7,84,844
Punjab	7,56,344‡
Burma	2,39,095
Central Provinces	6,06,757§
Assam	2,48,093
North-West Frontier Province	36,797
Baluchistan	14,575
TOTAL	52,14,031

* Includes Rs. 8,990 spent on Agricultural College and School buildings.

† Includes Rs. 61,093 spent on Sericulture.

‡ Includes Rs. 72,234 spent on Buildings, Original works.

§ Includes Rs. 65,318 spent on Botanical and other gardens.

APPENDIX I.

List of Agricultural Stations in British India.

Name of Province	Name of the Agricultural Station	Officer in immediate charge	Supervising Officer	Remarks
Imperial	Pusa, Bihar	Overseer	Imperial Agriculturist, Agricultural Research Institute, Pusa	
Bombay	Surat	Superintendent	Deputy Director of Agriculture, Northern Division, Poona.	
	Nadiad	Overseer	Ditto	Fodder farm.
	Dohad	Superintendent	Ditto	
	Dhulia	Ditto	Ditto	
	Jalgaon	Ditto	Ditto	
	Kopargaon	Overseer	Ditto	Fodder farm.
	Dharwar	Superintendent	Deputy Director of Agriculture, Southern Division, Dharwar.	
	Gadag	Overseer	Ditto	
	Gokak Canal	Superintendent	Ditto	
	Tegur	Divisional Inspector of Agriculture, Southern Division.	Ditto	Cattle-breeding farm.
	Alibag	Superintendent	Deputy Director of Agriculture, Konkan, Ratnagiri.	
	Ratnagiri	Ditto	Ditto	
	Kumpta	Ditto	Ditto	
	Mirpurkhas	Ditto	Deputy Director of Agriculture, Sind, Mirpurkhas.	Seed farm
	Mirpurkhas	Ditto	Ditto	
	Sukkur	Ditto	Ditto	
	Larkana	Ditto	Ditto	
	Landhi	Ditto	Ditto	

List of Agricultural Stations in British India—contd.

Name of Province	Name of the Agricultural Station	Officer in immediate charge	Supervising Officer	Remarks
Bombay—*contd.*	Ganeshkhind, Kirkee	Superintendent	Economic Botanist, Poona.	Botanical Station.
	Poona	Ditto	Professor of Agriculture, Poona Agricultural College.	Agricultural College farm.
	Kirkee	Manager	Ditto	Agricultural College Dairy.
	Manjri	Superintendent	Ditto	Sugarcane Experiment Station.
Madras	Coimbatore	Principal, Agricultural College and Research Institute and Superintendent, Central Farm, Coimbatore.	.....	Central farm attached to the Agricultural College.
	Samalkota	Manager	Deputy Director of Agriculture, I Circle.	
	Anakapalle	Ditto	Ditto	
	Hagari	Ditto	Deputy Director of Agriculture, II-III Circles.	
	Bantanahal	Ditto	Ditto	Sheep and Seed farm.
	Sirvel	Ditto	Assistant Director of Agriculture, II-III Circles.	
	Nandyal	Ditto	Ditto	
	Palur	Ditto	Deputy Director of Agriculture, IV Circle.	
	Koilpatti	Ditto	Deputy Director of Agriculture, V-VII Circles.	
	Manganallur	Ditto	Ditto	

Madras—*contd.*	Taliparamba . .	Manager . .	Assistant Director of Agriculture, VII Circle.	
	Kasargod . . .	Ditto . .	Ditto . . .	Coconut Stations.
Bengal . .	Dacca	Superintendent . .	Deputy Director of Agriculture, Eastern Circle, Dacca.	Central farm.
	Rajshahi . . .	Ditto . . .	Ditto.	
	Rangpur . . .	Dtito . . .	Ditto . . .	Cattle Farm.
	Rangpur Demonstration Farm.	Ditto . . .	Ditto.	
	Burirhat (Rangpur) . .	Ditto . . .	Ditto . . .	Tobacco growing farm.
	Chinsurah . . .	Ditto . .	Deputy Director of Agriculture, Western Circle, Calcutta.	
	Burdwan . . .	Ditto . . .	Ditto . . .	Private farm under the supervision of the Agricultural Department.
	Kalimpong. . . .	Manager	Ditto . . .	Private farm managed by St. Andrew's Colonial Homes.
	Berhampur . . .	Superintendent of Sericulture . . .	....	Sericulture Research Stations.
	Kurseong . . .			
	Kalimpong . . .			
Bihar and Orissa	Sabour	Superintendent . .	Professor of Agriculture . .	Home farm attached to the Agricultural College, Sabour.
	Bankipore . . .	Ditto . . .	Deputy Director of Agriculture, Patna Circle, Bankipore.	
	Dumraon . . .	Ditto . . .	Ditto . . .	Private farm under the supervision of the Agricultural Department.
	Ranchi (Kanke) . .	Ditto . . .	Deputy Director of Agriculture, Chota Nagpur Circle, Ranchi.	

List of Agricultural Stations in British India—contd.

Name of Province	Name of the Agricultural Station	Officer in immediate charge	Supervising Officer	Remarks
Bihar and Orissa—*contd.*	Purulia	Superintendent	Deputy Director of Agriculture, Chota Nagpur Circle, Ranchi.	Private demonstration farm under the supervision of the Agricultural Department.
	Cuttack	Ditto	Deputy Director of Agriculture, Orissa Circle, Cuttack.	
	Sambalpur (Halipali)	.....	.....	Private farm under the supervision of the Agricultural Department.
	Angul	.....	Deputy Commissioner, Angul	Ditto.
	Sipaya	Superintendent	M. M. Mackenzie	Cattle-breeding farm.
United Provinces	Cawnpore	the subordinate agricultural service.	Deputy Director of Agriculture, Central Circle, Cawnpore.	Seed farm.
	Kalianpur (Cawnpore)			District Farms including demonstration farms.
	Orai			
	Atarra (Banda)			
	Etawah			
	Hardoi			
	Mainpuri			
	Juhi (Cawnpore)			Sub-Stations including Usar farms.
	Abbaspur (Unao)			
	Partabgarh			Seed farm.
	Benares			
	Fyzabad			
	Ajudhia (Fyzabad)			District Farms including demonstration farms.
	Bikapur (Fyzabad)			
	Sultanpur			
	Rae-Bareli			
	Lucknow-Charbagh			

United Provinces—*contd.*	Lucknow-Marhi	All the farms of the United Provinces are managed by members of	Deputy Director of Agriculture, Eastern Circle, Partabgarh.
	Mirzapur		Ditto.
	Ghazipur.		
	Ballia		
	Sarwanpur		Sub-stations including Usar farms.
	Muswapur (Sultanpur)		
	Kalli Pachchham (Lucknow)		
	Bhiragovindpur (Rae Bareli)		
	Aligarh		Seed farm.
	Kalai Farm (Aligarh)		
	Nawabganj (Bareilly)		Deputy Director of Agriculture, Western Circle, Aligarh.
	Saharanpur		District Farms including demonstration farms.
	Bulundshahr		
	Muzaffarnagar		
	Biehhpuri (Agra)		
	Jachonda (Muttra)		
	Sunari (Agra)		
	Budaun		
	Gursikran (Aligarh)		Sub-Station.
	Gorakhpur		Deputy Director of Agriculture, North-Eastern Circle, Gorakhpur.
	Muttra		Economic Botanist, United Provinces, Cawnpore.
	Shahjahanpur		Agricultural Chemist, United Provinces, Cawnpore.
Punjab	Lyallpur	Superintendent	Professor of Agriculture, Punjab Agricultural College.
	Gurdaspur	Manager	Deputy Director of Agriculture, Gurdaspur.
	Sargodha	Ditto	Ditto
	Hansi	Ditto	Deputy Director of Agriculture, Hansi.

Seed farm.

List of Agricultural Stations in British India—concld.

Name of Province	Name of the Agricultural Station	Officer in immediate charge	Supervising Officer	Remarks
Burma	Mandalay	Superintendent	Deputy Director of Agriculture, Northern Circle, Mandalay.	
	Padu	Overseer	Ditto	Sub-stations.
	Bugyi	Ditto	Ditto	
	Hopin	Ditto	Ditto	
	Yawn ghwe	Ditto	Ditto	
	Hsum Hsai	Ditto	Ditto	
	Hmawbi	Ditto	Deputy Director of Agriculture, Southern Circle, Insein.	
	Tatkon	Ditto	Ditto.	
	Nyaunglebin (Pegu District).	Ditto	Ditto	
	Yodashe (Toungoo District)	Ditto	Ditto	District farms.
	Zigon (Tharrawaddy District).	Ditto	Ditto	
	Thilawa (Hanthawaddy District).	Ditto	Ditto	
	Taungtha (Myingyan District).	Ditto	Ditto	
	Pakokku	Ditto	Ditto	
	Pwinbyu (Minbu District)	Ditto	Ditto	
	Allanmyo (Thayetmyo District).	Ditto	Ditto	

Central Provinces	Nagpur	Superintendent	Principal, Agricultural College, Nagpur.	
	Akola	Ditto	Deputy Director of Agriculture, Western Circle, Nagpur.	
	Borgaon	Ditto	Ditto.	
	Tharsa	Ditto	Deputy Director of Agriculture, Southern Circle, Nagpur.	
	Sindewahi	Ditto	Ditto.	
	Labandih (Raipur)	Ditto	Ditto.	
	Chandkhuri	Ditto	Ditto.	
	Bilaspur	Agricultural Assistant	Ditto	Seed and Demonstration farm.
	Drug	Superintendent	Ditto.	
	Waraseoni	Ditto	Ditto.	
	Kawardha	Agricultural Assistant	Ditto	Made over to the Feudatory Chief of Kawardha State.
	Powarkhera (Hoshangabad)	Superintendent	Deputy Director of Agriculture, Northern Circle, Jubbulpore.	
	Adhartal and Khevi	Ditto	Ditto.	
	Betul	Ditto	Ditto	Seed farm.
	Damoh	Agricultural Assistant	Ditto	Seed and Demonstration farm.
Assam	Jorhat	Manager	Deputy Director of Agriculture, Assam Valley, Jorhat.	
	Kamrup	Ditto	Ditto.	
	Upper-Shillong	Ditto	Ditto.	
	Karimganj	Ditto	Deputy Director of Agriculture, Surma Valley, Shillong.	
	Shillong (Fruit Experiment Station).	Superintendent	Ditto.	
North-West Frontier Province.	Tarnab (Peshawar)	Manager	Agricultural Officer, North-West Frontier Province, Peshawar.	
	Haripur	Ditto	Ditto.	

APPENDIX II.

Operations of Non-Credit Agricultural Co-operative Societies in British India during 1917-18.

The two tables below include Agricultural Societies for—

A. 1. *Purchase, and Purchase and Sale.* These are societies intended to facilitate the purchase of agricultural requisites for members, such as societies which purchase seed, manure, implements, etc., for sale to their members. Societies of this character which also collect for joint sale the produce of members without making this their main object are included in this class.

2. *Production.* These are societies which have for their chief object an act of production without proposing to themselves sale as a direct object. This also includes societies for joint irrigation, for collective use of machinery, for assistance in horse and cattle breeding, etc.

3. *Production and Sale.* This class includes societies in which these two functions are united or in which one or the other predominates without it being possible to make a clear distinction between them. It covers all societies whose main object is the joint sale of any commodity whether such commodity is produced or worked up or prepared for sale by the society itself or by the members individually. It comprises all co-operative creameries, and distilleries, as well as societies whose main object is the sale of grain, cattle, eggs, ghee, etc., produced by their members.

4. Other forms of co-operation except insurance.

B. Insurance.

Operations of Non-Credit Agricultural Co-operative Societies in British India during 1917-18—contd.

A

Province	Class of Societies	Number of societies	Number of members	Sale of goods to members	Purchase of members' products	Working Capital	Profit and loss for the year	Remarks
				Rs.	Rs.	Rs.	Rs.	
Bombay	Purchase and Purchase and Sale.	30	1,765	58,957	...	59,550	6,905	
	Production	13	442	...	84	9,865	909	
	Production and Sale	18	1,844	29,156	1,78,719	73,065	3,016	
	Others	1	14	...	...	...	93	
	TOTAL	62	4,065	88,113	1,78,803	142,480	10,923	
Madras	Purchase and Purchase and Sale.	17	545	8,145	764	5,566	+645 —88	
	Production and Sale	2	24	...	...	660	—103	
	TOTAL	19	569	8,145	764	6,226	+454	
Bengal	Purchase and Purchase and Sale.	12	1,971	41,324	31,136	23,576	+2,876	
	Production	1	100	...	...	2,888	—105	
	Production and Sale	4	2,741	4,502	5,68,069	2,63,912	+5,08,517	
	TOTAL	17	4,812	45,826	5,99,205	290,376	+5,11,288	

Operations of Non-Credit Agricultural Co-operative Societies in British India during 1917-18—concld.

A

Province	Class of Societies.	Number of societies	Number of members	Sale of goods to members	Purchase of members' products	Working Capital	Profit and loss for the year	Remarks
				Rs.	Rs.	Rs.	Rs.	
Bihar and Orissa	Purchase and Purchase and Sale.	1	28	...	...	123	+3	Agricultural Association.
	Production and Sale . .	1	37	1,954	1,558	3,392	+212	
	Total .	2	55	1,954	1,558	3,515	+215	
United Provinces	Purchase and Purchase and Sale.	1	79	3,274	...	8,548	—244	
	Production and Sale . .	8	345	18,167	3,219	25,650	+2,534	
	Total .	9	424	21,441	3,219	34,198	+2,290	
Punjab .	Purchase and Purchase and Sale.	8	280	1,179	...	1,422	60	
	Production and Sale . .	34	680	...	16,208	7,104	416	
	Total .	42	960	1,179	16,208	8,526	476	

Burma	Purchase and Purchase and Sale.	9	361	...	...	...	...
	Production and Sale	37	1,958	36,376	98,973	19,431	—46
	Others	15	235	...	...	...	...
	TOTAL	61	2,554	36,376	98,973	19,431	—46
Central Provinces and Berar	Purchase and Purchase and Sale.	1	12	1,222	...	1,922	500
	Production	34	417	765	172	12,466	—47
	TOTAL	35	429	1,987	172	14,388	+453

(B) *Cattle Insurance.*

PROVINCE	Number of societies	Amount of risk insured	Premia collected	Supplementary contribution collected	NUMBER OF ANIMALS.		Claims paid	Cost of management	Funds in hand at end of year	Amount of risk re-insured	Amount of premia paid for reinsurance
					Insured	Lost					
		Rs.	Rs.	Rs.			Rs.	Rs.	Rs.	Rs.	Rs.
Bombay	4	19,888	803	186	345	6	27	64	598	...	...
Bengal	1	175	13	...	7	...	...	...	27	...	...
United Provinces	4	1,849	36	...	98	11	...	...	73	...	...
Punjab	1	5,120	128	29	70	...	...	5	152	...	...
Burma	379	2,75,825	11,808	...	7,814	180	3,643	446	17,439	1,53,360	6,034
Coorg *	10	4,563	4,606	2,084	565	143	1,604	...	5,086	...	

* In the absence of figures for 1917-18, those for 1916-17 are given here.

APPENDIX III.

List of Agricultural Colleges and Schools in British India during 1917-18.

Province	Name of College or School	Location of College or School.	Number of Students on the Roll	College Staff	Remarks
			(a) Post-graduate Training Institution.		
.....	Agricultural College, Pusa.	Pusa, Bihar . .	13	Director, Agricultural Research Institute, Pusa, is also the Principal. Imperial Agriculturist. Imperial Agricultural Chemist. Imperial Economic Botanist. Imperial Mycologist. Imperial Entomologist. Imperial Pathological Entomologist. Imperial Agricultural Bacteriologist.	Short courses in Sericulture and Lac-culture are temporarily given. The former course is for 1 year and the latter course is for 6 months. There were 9 students undergoing training in Sericulture during 1917-18.
			*(b) Provincial Agricultural Colleges.**		
Bombay .	Poona Agricultural College	Poona . . .	135	Principal, Agricultural College and Professor of Chemistry. Professor of Agriculture. Assistant Professor of Agriculture. Demonstrator in Agriculture. 2 Assistant Demonstrators in Agriculture. Assistant Professor of Chemistry. Lecturer in Chemistry.	Affiliated to the University of Bombay who confer the Degree of B.Ag., on passed students. The course is for 3 years. Students before admission must have passed the Previous Examination of the Bombay University or a similar examination of any Indian University.

					Professor of Botany. Assistant Professor of Botany. Assistant Professor of Mycology. Assistant Professor of Dairying. Assistant Professor of Physics and Mathematics. Assistant Professor of Entomology. Lecturer in Veterinary Science. Demonstrator in Veterinary Science.	A short course in Agriculture is also given to farmers' sons who know English but who are not qualified to take the University course in agriculture. This course lasts for 1 year. It was held in abeyance in 1917-18 on account of the hostel and the greater part of the college buildings being utilized as a war hospital.
Madras	Agricultural College, Coimbatore	Coimbatore	99	Principal, Agricultural College. Assistant Principal. Veterinary Assistant. Engineering Assistant. 3 Agricultural Assistants. Farm Office Manager. Government Agricultural Chemist. Senior Assistant to Agricultural Chemist. 4 Assistants to Agricultural Chemist. Government Mycologist. 3 Assistants to Mycologist. Government Economic Botanist. 2 Assistants to Economic Botanist. Government Entomologist. 3 Assistants to Entomologist. Government Lecturing Botanist. 2 Assistants to Lecturing Botanist.	Two courses of instruction are given :— (1) The first course (2 years) for Certificate of Proficiency in practical agriculture, and (2) The second course (18 months in continuation of the 1st course) for the Diploma of Licentiate in Agriculture.

P 2

* The minimum qualification for admission to the Provincial Agricultural Colleges for the diploma course is ordinarily the Entrance *i.e.*, Matriculation or the School Final Examination of Indian Universities.

List of Agricultural Colleges and Schools in British India during 1917-18—contd.

Province.	Name of College or School.	Location of College or School.	Number of Students on the Roll.	College Staff.	Remarks.
				(*b*) *Provincial Agricultural Colleges**—contd.	
Central Provinces.	Agricultural College, Nagpur.	Nagpur	77	Principal, Agricultural College. Farm Superintendent and Demonstrator in Agriculture. First Agricultural Assistant Lecturer. Second Agricultural Lecturer and Demonstrator. Dairy Assistant. Assistant Demonstrator in Agriculture. Economic Botanist. Assistant Lecturer in Botany. Agricultural Chemist. Assistant Lecturer in Chemistry. Lecturer in Entomology. Senior Veterinary Assistant in charge Menagerie and Demonstrator in Veterinary Science. Lecturer in Surveying. Farm Engineering. This subject is taught with the help of External Lecturers and Demonstrators from the Public Works Department, the School of Engineering and the School of Handicrafts, Nagpur, and the Agricultural Staff of the College.	Two courses of instruction are given :— (1) Four years course for the Diploma of Licentiate of Agriculture, and (2) Two years Diploma course for the sons of malguzars and substantial cultivators who intend to manage their own lands, and to whom a full scientific course is unnecessary.

Bihar and Orissa	Agricultural College, Sabour.	Sabour (near Bhagalpur).	52	Principal and Agricultural Chemist. Professor of Agriculture. Economic Botanist. Assistant Economic Botanist. Assistant Professor of Agriculture. Assistant Professor of Entomology. Assistant Professor of Mycology. Assistant Professor of Chemistry and Physics. Assistant Professor of Botany. Demonstrator in Entomology. Demonstrator in Botany. Demonstrator in Chemistry and Physics. Demonstrator in Agriculture. Fieldman in Mycology. Fieldman in Entomology. Veterinary Science. In teaching this subject temporary assistance is given by the Veterinary Assistant, Bhagalpur.	Two courses of instruction are given :— (1) Three years course (Diploma) and (2) Two years course (Certicate). Besides these, short courses are also given. There were 2 students in the *Bhadoi* short course class and 3 in the *Rabi* Short Course class during 1917-18.
United Provinces	Agricultural College, Cawnpore.	Cawnpore	97	Principal, Agricultural College, and Economic Botanist. Assistant Economic Botanist. Agricultural Chemist. Agricultural Engineer. Assistant to Principal and Farm Superintendent. 6 Lecturers. 5 Demonstrators. 1 Mechanical Instructor.	Two courses of instruction are given :— (1) Diploma course for 4 years and (2) Two years or Vernacular course.

* The minimum qualification for admission to the Provincial Agricultural Colleges for the diploma course is ordinarily the Entrance *i.e.*, Matriculation or the School Final Examination of Indian Universities.

List of Agricultural Colleges and Schools in British India during 1917-18—concld.

Province.	Name of College or School.	Location of College or School.	Number of Students on the Roll.	College Staff.	Remarks.
		(*b*) *Provincial Agricultural Colleges**—contd.			
Punjab	Punjab Agricultural College	Lyallpur	82	Principal, Agricultural College and Professor of Agriculture. Assistant Professor of Agriculture. Teaching and Research Assistant of Agriculture. Superintendent in charge of Vernacular Class. Professor of Chemistry. 2 Assistant Professors of Chemistry. Demonstrator in Chemistry. Lecture Table Assistant of Chemistry. Professor of Botany. 2 Assistant Professors of Botany. 2 Teaching and Research Assistants of Botany. Assistant Professor of Entomology. Teaching and Research Assistant of Entomology. Lecturer in Physics and Mathematics. Lecturer in Veterinary Science. Lecturer in Land Administration and Revenue. Lecturer in Land Surveying. Professor of Agricultural Engineering.	Affiliated to the Punjab University. Two courses of instruction are given :— (1) Two years course for Leaving Certificate and (2) Four years course for the Licentiate in Agriculture. Besides, there is a Vernacular Class which lasts for 1 year only. There were 37 students on the rolls during 1917-18.

				Head Mechanic in Agricultural Engineering. *Assistant* Professor of *English.*	
			(c) *Vernacular Agricultural Schools.*		
Bombay . .	Vernacular Agricultural School, Loni (in Marathi).	Loni, District Poona.	50	Head Master (A Graduate Fieldman B.Ag., of Bombay University). Non-graduate Fieldman. Assistant Master.	2 years' course.
Do. . .	Vernacular Agricultural School, Devi-hosur (in Kanarese).	Devi-hosur, District Dharwar.	32	Head Master (A Graduate Fieldman B.Ag., of Bombay University. Non-graduate Fieldman. Assistant Master.	2 years' course.
Do. . .	Vernacular Agricultural School, Jambul (in Marathi).	Jambul, District Thana.	31	Head Master (A Graduate Fieldman B.Ag., of Bombay University.) Non-graduate Fieldman. Assistant Master.	2 years' course.
Do. . .	Vernacular Agricultural School, Mirpurkhas (in Sindhi).	Mirpurkhas, District Thar and Parkar, Sind.	9	Head Master (Agricultural Graduate).	1 year course.

* The minimum qualification for admission to the Provincial Agricultural Colleges for the diploma course is ordinarily the Entrance *i.e.*, Matriculation or the School Final Examination of Indian Universities.

APPENDIX IV.

Showing the working of the Provincial Veterinary Departments during 1917-18

Province	No. of superior staff (both Imperial and Provincial service officers)	Research	Dispensaries and hospitals			District Staff and work						
			No. of dispensaries	No. of Veterinary assistants employed.	No. of cases treated and castrations performed	No. of Inspectors	No. of Veterinary assistants	No. of outbreaks in which inoculation was undertaken	Cases treated and castrations performed	Deaths uninoculated	Inoculations	Deaths after inoculation
Bombay	4+5*	Jhone's disease, tuberculosis, Schistogomiasis in cattle, sheep and goats; and examination of specimens.	54	54	161,955	5	54	452	46,052	7,686	62,695	168
Madras	2+4†	Examination of specimens, etc.	40	40	51,765¶	8**	42	670	25,593	17,169	110,900	417
Bengal	1+6‡	Ditto	27	28	37,468	6††	74	553	67,333	12,020	69,033	299
Bihar and Orissa	1	Ditto	24	22	39,671	9	68	805	69,122	7,030	108,950	348
United Provinces	1+2§	Ditto	83	83	109,712	16‡‡	99	736	71,688	6,970	48,974	20
Punjab	8+4‖	Dourine, rabbies, surra, etc.	128	129	380,037	18	116	691	154,673	7,086	140,387	154
Burma	2+3§	Examination of specimens, etc.	1	1	2,440	16§§	175¶¶	173	80,004	1,450	12,807	124
Central Provinces	1+2§	Ticks, foot-rot in sheep, examination of specimens, etc.	80	80	284,513	11‖‖	15	511	159,591	5,301	61,414	287
Assam	1	Examination of specimens, etc.	3	3	4,296	3	36	693	49,891	9,814	45,704	369
North-West Frontier Province	1	Ditto	17	17	45,481	3	17	67	19,603	915	20,260	3
Sind	1+1§	Ditto	14	14	22,951	..	14	43	3,352	816	5,023	22
Baluchistan			5	5	5,804	1	5	..	789	..	..	..
Ajmer-Merwara			2	3	1,341	..	3	..	250	..	..	..
Total for 1917-18	49		478	479	1,147,494	96	718	5,413	747,941	70,273	686,147	2,211
Total for 1916-17	48		463	465	954,599¶	96	690	4,567	766,140	63,438	667,990	2,668

*1 Deputy Superintendent, 2 Indian Professors, and 2 Assistant Professors.
†2 Deputy Superintendents, 1 Assistant Principal, and 1 Lecturer.
‡1 Deputy Superintendent, 1 Assistant Principal, and 3 Lecturers.
§ Deputy Superintendents.
‖1 Deputy Superintendent, 2 Indian Professors, and 1 House Surgeon.
¶ Not including castrations and cases supplied with medicines but not brought to hospital.

**The total strength was 12. Of these one was attached to the Madras Veterinary College, one lent to the Coimbatore Agricultural College, one stationed at the Cattle Quarantine Depôt, and one was on military duty.
††The total strength was 16. One was employed in hospital and 9 as Glanders Inspectors.
‡‡The total strength was 20. Two were employed as Farm Overseers and two more in charge of Research Station and Stallion Depôt.
§§Excluding three employed in educational work.
‖‖Excluding three on military duty and one in charge of Menagerie and Government farm, Nagpur.
¶¶Including those employed in the Shan States.

APPENDIX V.

Showing the details as to students of veterinary colleges and schools during the year 1917-18.

Veterinary colleges and schools	Name of course of instruction	Number of students						Students admitted during the year, classed by educational qualifications		
		Admitted during the year		Passed final examination during year	Failed to pass final examination	Remaining under instruction at end of year		Matriculates or with higher qualifications	Knowing some English but not matriculates	Knowing no English or very little English
		Scholarship holders	Others			In ordinary course	Instruction prolonged by reason of failure to pass			
1	2	3	4	5	6	7	8	9	10	11
Bombay Veterinary College*	3 years' English course	15	26	17	10	43	49	14	27	..
Madras Veterinary College.	Ditto.	40	11	17	8	95	8	51	..	..
Bengal Veterinary College	Ditto.	48	11	31	19	76	41	12	47	..
Punjab Veterinary College	3 years' course	15	36	36	9†	86	16	2	21	28
	4 years' course	8	20	..	..	66	1	3	25	..
	Post-graduate course	..	..	2	..	..	..	..	..	..
Burma — Insein Veterinary School.	3 years' vernacular course	21	..	16	..	37	..	..	..	21
Burma — Taunggyi Veterinary School.	1½ years' vernacular course	6	..	4	..	6	..	..	..	6
Total for 1917-18 . .	..	153	104	123	46	409	115	82	120	55
Total for 1916-17 . .	..	117	97	137	38	337	127	59	104	31

* Information in columns 3 to 11 refers to the collegiate year, *i.e.*, Jan.-Dec., 1917.
† Five failing in one subject only were to be re-examined in June 1918.

APPENDIX VI.

List of Agricultural Publications in India during 1917-18.

No.	Title	Author	Where published
	GENERAL AGRICULTURE.		
1	The *Agricultural Journal of India*, Vol. XII, Parts III and IV and Vol. XIII, Parts I and II. Price Rs. 2 or 3*s.* per part; annual subscription Rs. 6 or 8*s.* 6*d.*	Edited by the Agricultural Adviser to the Government of India, Pusa.	Messrs. Thacker Spink and Co., Calcutta.
2	Special Indian Science Congress Number of the Agricultural Journal of India, 1918. Price Rs. 2 or 3*s.*	Issued from the Agricultural Research Institute, Pusa.	Ditto.
	Scientific Reports of the Agricultural Research Institute Pusa (including the Report of the Imperial Cotton Specialist) for 1916-17. Price As. 9 or 10*d.*	Ditto.	Government Printing, India, Calcutta.
4	Report on the Progress of Agriculture in India for 1916-17. Price As. 12 or 1*s.* 1*d.*	Agricultural Adviser to the Government of India, Pusa.	Ditto.
5	Proceedings of the Board of Agriculture in India, held at Poona on the 10th December 1917 and following days (with Appendices). Price As. 13 or 1*s.* 3*d.*	Issued by the Agricultural Adviser to the Government of India, Pusa.	Ditto.
6	Water Hyacinth (*Eichornia crassipes*): Its value as a fertilizer. Bulletin No. 71 of the Pusa Agricultural Research Institute. Price As. 5 or 6*d.*	R. S. Finlow, B.Sc., F.I.C., Government Fibre Expert, Bengal; and K. McLean, B.Sc., Deputy Director of Agriculture, Eastern Bengal.	Ditto.
7	New Agricultural Implements for India. Bulletin No. 73 of the Pusa Agricultural Research Institute. Price As. 3 or 4*d.*	G. S. Henderson, N.D.A., N.D.D., Officiating Imperial Agriculturist.	Ditto.
8	A study of the Indigo soils of Bihar. The Urgent Necessity of Immediate Phosphate Manuring if Crops are to be maintained. Indigo Publication No. 1. Price Rs. 1-4 or 2*s.*	W. A. Davis, B.Sc. A.C.G.I., Indigo Research Chemist to the Government of India.	Messrs. Thacker Spink and Co., Calcutta.

List of Agricultural Publications in India during 1917-18—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —contd.		
9	Present Position and Future Prospects of the Natural Indigo Industry. III. the Future of Natural Indigo in India. Indigo Publication No. 2. Price As. 10 or 1*s*.	W. A. Davis, B.SC., A.C G.I., Indigo Research Chemist to the Government of India.	Messrs. Thacker Spink and Co. Calcutta.
10	Flax in India. Price As. 4 or 5*d*.	R. S. Finlow, B.Sc., Fibre Expert to the Government of Bengal.	Government Printing India, Calcutta.
11	Annual Report of the Board of Scientific Advice for India for the year 1916-17. Price Rs. 1-2 or 1*s*. 9*d*.	Issued by the Board of Scientific Advice for India.	Ditto.
12	Agricultural Statistics of India, 1915-16. Vols. I and II. Price Rs. 2 and R. 1, respectively.	Issued by the Department of Statistics, India.	Ditto.
13	Estimates of Area and Yield of Principal Crops in India, 1916-17. Price As. 8.	Ditto.	Ditto.
14	Summary Tables of Agricultural Statistics of British India, 1915-16. Price As. 4 or 5*d*.	Ditto.	Ditto.
15	Prices and Wages in India, Thirty-third Issue. Price Rs. 2 or 3*s*.	Ditto.	Ditto.
16	Agricultural Statistics of Bengal for 1916-17. Price R. 1 or 1*s*. 6*d*.	Government of Bengal, Revenue Department.	Bengal Secretariat Book Depot, Calcutta.
17	Annual Report of the Department of Agriculture, Bengal, for the year ending 30th June, 1917. Price As. 5 or 6*d*.	Issued by the Department of Agriculture, Bengal.	Ditto.
18	Annual Reports of Expert Officers of the Department of Agriculture, Bengal, for the year ending 30th June, 1917. Price R. 1-6 or 2*s*.	Ditto.	Ditto.
19	Season and Crop Report of Bengal for 1917-18. Price R. 1-5 or 2*s*.	Ditto.	Ditto.
20	Report on the Crop-Cutting Experiments during the quinquennium from 1912-13 to 1916-17. Price As. 5.	Ditto.	Ditto.

List of Agricultural Publications in India during 1917-18—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —contd.		
21	*Dhaincha* green manure. Leaflet No. 3 of 1917 (in English and Bengali).	F. Smith, B.Sc., F.H.A.S., M.R.A.S.E., Deputy Director of Agriculture, Western Circle, Bengal.	Department of Agriculture, Bengal.
22	A Note on Water Hyacinth	R. S. Finlow, B.Sc., A.I.C., Fibre Expert, Bengal.	Ditto.
23	Leaflet on Cotton cultivation (in Bengali).	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depot, Calcutta.
24	Report of the Proceedings of the All-India Cow Conference held in Calcutta in December 1917.	All-India Cow Conference Association, Calcutta.	W. N. Printing Works Calcutta.
25	Annual Report of the Department of Agriculture, Bihar and Orissa, for the year ending 30th June, 1917. Price As. 8 or 9*d*.	Issued by the Department of Agriculture, Bihar and Orissa.	Bihar and Orissa Government Press, Patna.
26	Report on the Agricultural Activities of Government in Bihar and Orissa for the year ending 30th June 1917. Price R. 1-6 or 1*s*. 10*d*.	Ditto.	Ditto.
27	Season and Crop Report of Bihar and Orissa for 1917-18. Price As. 12 or 1*s*.	Ditto.	Ditto.
28	Agricultural Statistics of Bihar and Orissa for 1916-17. Price R. 1 or 1*s*. 4*d*.	Ditto.	Ditto.
29	Note on Some Sugarcanes bred by the Government Sugarcane Expert, Coimbatore, and considered likely to be suitable for Bihar. Bihar and Orissa Department of Agriculture Bulletin No. 1 of 1918-19.	Ditto.	Ditto.
30	Experimental Cultivation of *Tiparees*. Bihar and Orissa Department of Agriculture Bulletin No. 2 of 1918-19.	Ditto	Ditto.
31	Revised Rules for the Management of Breeding Bulls. Bihar and Orissa Department of Agriculture Bulletin No. 3 of 1918-19.	Ditto.	Ditto.

List of Agricultural Publications in India during 1917-18—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE. —contd.		
32	*Agricultural Journal*, Vol. IV No. 2 and Vol. V, No. 1 (half yearly) Subscription R. 1 per annum..	Issued by the Department of Agriculture, Bihar and Orissa.	Bihar and Orissa Government Press, Patna.
33	Report on the Administration of the Agricultural Department of the United Provinces of Agra and Oudh for the year ending 30th June, 1917. Price As. 6 or 6*d*.	Issued by the Department of Agriculture, United Provinces.	Government Press, United Provinces, Allahabad.
34	Season and Crop Report of the United Provinces of Agra and Oudh for 1916-17. Price As. 8 or 9*d*.	Ditto.	Ditto.
35	Report on the Agricultural Stations of the Western Circle, United Provinces of Agra and Oudh, for the year ending 30th June 1917. Price As. 8 or 9*d*.	Ditto.	Ditto.
36	Report on the Agricultural Stations of the Central Circle, United Provinces of Agra and Oudh, for the year ending 30th June 1917. Price R. 1-4 or 2*s*.	Ditto.	Ditto.
37	Combined Annual Report of Partabgarh and Benares Agricultural Stations, United Provinces, for the year ending 30th June, 1917. Price As. 6 or 6*d*.	Issued by the Department of Agriculture, United Provinces.	Government Press, United Provinces, Allahabad.
38	Manures. Cultivators' pamphlet No. 15.	B. C. Burt, B.Sc., Deputy Director of Agriculture, Central Circle, United Provinces.	Ditto.
39	Trenching: A Sanitary and Profitable Method of Disposing of all Refuse from House, Garden, Kitchen, Stable, Cattleshed, Latrine and Village. Bulletin No. 2 of the Department of Agriculture, Ewing Christian College, Allahabad. Price As. 8.	Sam Higginbottom, M.A., Ewing Christian College, Allahabad.	Baptist Mission Press, Calcutta.

List of Agricultural Publications in India during 1917-18—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —contd.		
40	The Fruit Garden in India (in English and Urdu). Price R. 1-8.	Chater Sen Digambari, Head Clerk, Government Botanical Gardens, Saharanpur.	Mufid-i-Am Press, Lahore.
41	Annual Report of the Department of Agriculture Punjab, for the year ending 30th June 1917. Price R. 1 or 1*s.* 6*d.*	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
42	Season and Crop Report of the Punjab for the year 1916-17. Price As. 12 or 1*s.*	Ditto.	Ditto.
43	Tables of the Agricultural Statistics of the Punjab for the year 1916-17.	Ditto.	Ditto.
44	Annual Report of the Lawrence Gardens for 1917-18. Price As. 2 or 3*d.*	Ditto.	Ditto.
45	Experiments, etc., at the Agricultural Station, Lyallpur, Punjab, September 1917. Price As. 8.	Professor of Agriculture, Lyallpur.	Ditto.
46	The Agricultural Problems of India.	Rai Bahadur Ganga Ram, C.I.E., M.V.O.	Simla Army Press.
47	Expenses and Profits of Cultivators in the Punjab.	W. S. Hamilton, I.C.S.	Government Printing, Punjab, Lahore.
48	Annual Report of the Department of Agriculture, Bombay Presidency, for 1916-17. Price As. 8. or 9*d.*	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
49	Season and Crop Report of the Bombay Presidency for 1916-17. Price As. 5 or 6*d.*	Ditto.	Ditto.
50	The Utilization of Inferior Grass Herbage : Experiments at the Tegur Cattle Farm. Bulletin No. 87 of the Department of Agriculture, Bombay. Price As. 9 or 10*d.*	M. L. Kulkarni, Acting Deputy Director of Agriculture, Southern Division, Dharwar	Ditto.
51	Stone Roller for Threshing *Jowar*. Bombay Department of Agriculture Leaflet No. 6 of 1917.	Issued by the Department of Agriculture, Bombay.	Ditto.

List of Agricultural Publications in India during 1917-18—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —contd.		
52	Method of Obtaining Good Seed in *Jowar*. Bombay Department of Agriculture Leaflet No. 1 of 1918.	Issued by the Department of Agriculture, Bombay.	Government Press, Lahore. Central
53	Chaffing of *Jowar* Fodder before Stacking. Bombay Department of Agriculture Leaflet No. 2 of 1918.	Ditto.	Ditto.
54	Hay-making with Spear Grass. Bombay Department of Agriculture Leaflet No. 3 of 1918.	Ditto.	Ditto.
55	Calendar of the Agricultural College, Poona, for 1917-18.	Ditto.	Ditto
56	All about the Mango (in Marathi) Price As. 12.	V. R. Gadgil, B.Ag.	Arya Bhusan Press, Poona.
57	Report on the Operations of the Department of Agriculture, Madras Presidency, for the official year, 1916-17.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
58	Year Book of the Department of Agriculture, Madras, 1918. Price R. 1 or 1*s.* 9*d.*	Ditto.	Ditto.
59	The Madras Agricultural Calendar for 1918-19. Price As. 12 or 1*s.*	Ditto.	Ditto.
60	Report of the work of the Anakapalle Agricultural Station for 1916-17. Price As. 1-6 or 2*d.*	Ditto.	Ditto.
61	Report of the work of the Taliparamba Agricultural Station for 1916-17. Price A. 1 or 1*d.*	Ditto.	Ditto.
62	Report of the work of the Samalkota Agricultural Station for the year 1916-17. Price As. 2 or 2*d.*	Ditto.	Ditto.
63	Report of the work of the Palur Agricultural Station for the year 1916-17. Price As. 3 or 3*d.*	Ditto.	Ditto.
64	Report of the work of the Koilpatti Agricultural Station for the year 1916-17. Price As. 3 or 3*d.*	Ditto.	Ditto.

List of Agricultural Publications in India during 1917-18—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —contd.		
65	Report of the work of the Hagari Agricultural Station for the year 1916-17. Price As. 2 or 2*d*.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
66	Report of the work of the Coimbatore Agricultural Station for the year 1916-17. Price As. 1-6 or 2*d*.	Ditto.	Ditto.
67	Report of the work of the Manganallur Agricultural Station for the year 1916-17. Price As. 3 or 3*d*.	Ditto.	Ditto.
68	Report of the work of the Nandyal Agricultural Station for the year 1916-17. Price As. 1-6 or 2*d*.	Ditto.	Ditto.
69	Report of the work of the Sirvel Agricultural Station for the year 1916-17. Price 1 anna or 1*d*.	Ditto.	Ditto.
70	Report of the work of the Coconut Stations in the Kasargod Taluk for 1916-17. Price As. 4.	H. C. Sampson, B.Sc., Deputy Director of Agriculture, V and VII Circles, Madras.	Ditto.
71	A Survey of the Madras Dairy Trade. Bulletin No. 73. Price As. 8 or 9*d*.	Allen Carruth, Deputy Director of Agriculture for Live Stock, Madras.	Ditto.
72	Indigo Manufacture in Madras. Madras Department of Agriculture Bulletin No. 74.	F. Marsden, D.Sc., Special Indigo Research Officer.	Ditto.
73	Green Manure Crops Suitable for the Northern Circars and the Ceded Districts. Leaflet No. VI of 1917.	Issued by the Department of Agriculture, Madras.	Ditto
74	Green Manure Crops Suitable for Tamil Districts. Leaflet No. VII of 1917.	Ditto.	Ditto.
75	*Sorghum* for fodder on the Black Soils of Bellary District. Leaflet No. VIII of 1917.	Ditto.	Ditto.
76	The Coconut. Leaflet No. IX of 1917.	Ditto.	Ditto.

List of Agricultural Publications in India during 1917-18—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —contd.		
77	Songs on Improved Methods of Paddy Cultivation. Leaflet No. X of 1917.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
78	Songs on Preventive Methods to protect Mango Flowering. Leaflet No. XI of 1917.	Ditto.	Ditto.
79	Hints to Ryots of the IV Circle on Green Manuring. Leaflet No. XII of 1917.	Issued by the Department of Agriculture, Madras.	Ditto.
80	Report on the working of the Department of Agriculture, Central Provinces and Berar, 1916-17. Price R. 1 or 1*s.* 6*d.*	Issued by the Department of Agriculture, Central Provinces and Berar.	Government Press, Central Provinces, Nagpur.
81	Season and Crop Report of the Central Provinces and Berar for 1916-17. Price As. 8 or 9*d.*	Ditto.	Ditto.
82	Report on Agricultural Stations, Southern Circle, Central Provinces, for 1916-17. Price R. 1.	Ditto.	Ditto.
83	Report on Agricultural Stations, Northern Circle, Central Provinces, for 1916-17. Price As. 8.	Ditto.	Ditto.
84	Report on Agricultural Stations, Western Circle, Central Provinces, for 1916-17. Price As. 8.	Ditto.	Ditto.
85	Report on the Experimental Farm attached to the Agricultural College, Nagpur, for 1916-17. Price As. 8.	Ditto.	Ditto.
86	Report on Demonstration Work in the Southern Circle, Central Provinces, for 1916-17. Price As. 8.	Ditto.	Ditto.
87	Report on Demonstration Work in the Northern Circle, Central Provinces, for 1916-17. Price As. 8.	Ditto.	Ditto.

List of Agricultural Publications in India during 1917-18—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —contd.	—	
88	Report on Demonstration Work in the Western Circle, Central Provinces, for 1916-17. Price As. 8.	Issued by the Department of Agriculture, Central Provinces and Berar.	Government Press, Central Provinces, Nagpur.
89	Report on Agricultural College, Botanical and Chemical Research, and Maharajbagh Menagerie for 1916-17. Price As. 8.	Ditto.	Ditto.
90	The *Agricultural and Co-operative Gazette* (Monthly) from July 1917 to June 1918. Price As. 2 per copy.	Issued by the Department of Agriculture, Central Provinces and Berar.	Shalom Press, Nagpur.
91	A Scheme for Cattle-breeding in Chhattisgarh, Central Provinces. Price As. 8.	D. Clouston, M.A., B.Sc., Officiating Director of Agriculture, Central Provinces.	Government Press, Central Provinces, Nagpur.
92	Report on the Operations of the Department of Agriculture, Burma, for the year ending 30th June, 1917. Price As. 8 or 9*d*.	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
93	Season and Crop Report of Burma for 1916-17. Price As. 10 or 11*d*.	Ditto.	Ditto.
94	Annual Reports of the Agricultural Stations, the Assistant Botanist of the Northern Circle, the Assistant Entomologist and the Agricultural Chemist to the Government of Burma for the year ending 30th June 1917. Price As. 2 or 3*d*.	Ditto.	Ditto.
95	Courses of Agricultural Instruction given by the Department. Burma Department of Agriculture Leaflet No. 48.	Ditto.	Ditto.
96	Cultivators' Leaflet No. 47 on *Pebyugale* (in English and Burmese).	Ditto.	Ditto.
97	Tables of Agricultural Statistics of Lower Burma for 1917-18.	Ditto.	Ditto.

List of Agricultural Publications in India during 1917-18—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —contd.		
98	A Handbook of Nature Study and Simple Agricultural Teaching for the Primary Schools of Burma. Price Rs. 2-8.	R. Thompstone, B.Sc., Deputy Director of Agriculture, Burma.	Messrs. Longmans, Green & Co., London.
99	Annual Report of the Department of Agriculture, Assam, for the year ending 30th June, 1917. Price As. 8 or 9*d*.	Issued by the Department of Agriculture, Assam.	Assam Secretariat Printing Office, Shillong.
100	Season and Crop Report of Assam for the year 1917-18. Price As. 8 or 9*d*.	Ditto.	Ditto.
101	Tables of Agricultural Statistics of Assam for 1917-18.	Ditto.	Ditto.
102	Annual Report of the Jorhat Agricultural Experiment Station for the year ending 30th June, 1917.	Ditto.	Ditto.
103	Annual Report of the Upper Shillong Agricultural Experiment Station for the year ending 30th June 1917.	Ditto.	Ditto.
104	Annual Report of the Kamrup Sugarcane Experiment Station for the year ending 30th June, 1917.	Ditto.	Ditto.
105	Annual Report of the Karimganj Agricultural Experiment Station for the year ending 30th June, 1917.	Ditto.	Ditto.
106	Annual Report of the Fruit Experiment Station, Shillong, for the year ending 30th June 1917.	Ditto.	Ditto.
107	Annual Report of the Agricultural Experiments and Demonstrations in Assam for the year ending 30th June 1917.	Ditto.	Ditto.
108	Water Hyacinth (in Bengali) .	Ditto.	Ditto.
109	Cotton in Assam. Assam Department of Agriculture Leaflet No. 1 of 1918.	Ditto.	Ditto.

List of Agricultural Publications in India during 1917-18—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —contd.		
110	Report on Tea Culture in Assam for the year 1917. Price As. 8 or 9*d*.	J. McSwiney, M.A., I.C.S., Director of Land Records and Agriculture, Assam.	Assam Secretariat Printing Office, Shillong.
111	Annual Report of the Peshawar Agricultural Station at Tarnab for the year ending 30th June, 1917.	Issued by the Department of Agriculture, North-West Frontier Province.	Government Press, Peshawar.
112	Report on the Season and Crops of the North-West Frontier Province for 1916-17. Price R. 1 or 1*s*. 4*d*.	Ditto.	Ditto.
113	The Improvement of Fruit Culture in Baluchistan. Quetta Fruit Experiment Station Bulletin No. 9.	A. Howard, C.I.E., and G. L. C. Howard, M.A., Imperial Economic Botanists.	Baptist Mission Press, Calcutta.
114	Review of the Progress of Agriculture in States of Central India for 1916-17.	Bernard Coventry, C.I.E., Agricultural Adviser to States in Central India.	Indore C. I. A. Govt. Press.
115	The Zemindar Hitkari or the Zemindars' Friend. Price Rs. 6-8.	Major-General His Highness the Maharaja Sir Madho Rao Scindia, G.C.S.I., G.C.V.O., L.L.D., D.C.L.	Alijah Darbar Press. Lashkar, Gwalior.
116	Annual Report of the Department of Agriculture, Mysore, 1916-17.	Issued by the Department of Agriculture, Mysore.	Government Press, Bangalore.
117	Mysore Agricultural Calendar for 1918.	Ditto.	Ditto.
118	Cultivation of the Areca Palm. Mysore Department of Agriculture Bulletin No. 10. (General Series).	Ditto.	Ditto.
119	Tea Roots, Part II, Price As. 8.	Issued by the Scientific Department of the Indian Tea Association.	Star Printing Works, Calcutta.
120	Memorandum on the Use of Artificial Manures on the Tea Estates of Assam and Bengal during the decade 1907-17.	Ditto.	Ditto.

List of Agricultural Publications in India during 1917-18—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —concld.		
121	*Quarterly Journal of the Indian Tea Association.* Price As. 6 per copy.	Issued by the Scientific Department of the Indian Tea Association.	Catholic Orphan Press, Calcutta.
122	The *Journal of the Madras Agricultural Students' Union* (Monthly), Annal Subscription Rs. 2 (including postage).	Madras Agricultural Students' Union, Coimbatore.	Literary Sun Press, Coimbatore.
123	The *Journal of Dairying and Dairy-Farming in India* (Quarterly). Subscription Rs. 5 per annum (including membership).	Published by the Indian Committee of the Dairy Education Association, Quetta.	Messrs. Thacker Spink & Co., Calcutta.
124	*Poona Agricultural College Magazine* (Quarterly). Annual Subscription Rs. 2.	College Magazine Committee, Poona.	Arya Bhusan Press, Poona.
125	The *Planters' Chronicle* (weekly)	United Planters' Association of South India.	Daily Post Press, Bangalore.
126	The *Indian Journal of Economics* (Quarterly). Annual Subscription Rs. 12.	Department of Economics, University of Allahabad.	Pioneer Press, Allahabad.
127	*Bengal Economic Journal* (Quarterly). Annual Subscription Rs. 10.	Bengal Economic Association.	The Calcutta General Printing Co. Ltd.
128	*Mysore Economic Journal* (Monthly). Annual Subscription. Rs. 4.	Mysore Economic Conference.	Vokkaligara Press, Bangalore.
	AGRICULTURAL CHEMISTRY.		
129	"Heart Damage" in Baled Jute. Memoirs of the Department of Agriculture in India. Chemical Series, Vol. V, No. 2. Price R. 1 or 1*s.* 6*d.*	R. S. Finlow, B.Sc., F.I.C., F.C.S., Fibre Expert to the Government of Bengal.	Messrs. Thacker Spink & Co., Calcutta.
130	Sugar and the Sugarcane in the Gurdaspur District, (Bulletin No. 69) of the Pusa Agricultural Research Institute. Price As. 14 or 1*s.* 3*d.*	J. H. Barnes, B.Sc., F.I.C., F.C.S., Principal, Punjab Agricultural College, and Agricultural Chemist to the Government of the Punjab.	Government Printing, India, Calcutta.

List of Agricultural Publications in India during 1917-18—contd.

No.	Title	Author	Where published
	AGRICULTURAL CHEMISTRY —contd.		
131	The Composition of some Indian Feeding Stuffs. Bulletin No. 70 of the Pusa Agricultural Research Institute. Price As. 10 or 1*s*.	Jatindra Nath Sen, M.A., F.C.S., Officiating Imperial Agricultural Chemist.	Government Printing, India, Calcutta.
132	Prussic Acid in Burma Beans. Bulletin No. 79 of the Pusa Agricultural Research Institute. Price As. 2 or 3*d*.	F. J. Warth, B.SC., M.SC., Agricultural Chemist to the Government of Burma and Ko KoGyi, Assistant to the Agricultural Chemist.	Ditto.
133	The Value of Phosphatic Manures in India and the possibility of their Manufacture on a Larger Scale: Being evidence to the Committee appointed to discuss this question (Subject IX) at the meeting of the Board of Agriculture, Poona, 1917. (Bulletin No. 81 of the Pusa Agricultural Research Institute). Price As. 4 or 5*d*.	Issued from the Agricultural Research Institute, Pusa.	Ditto.
	BOTANY.		
134	The Inheritance of Characters in Rice, I. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. IX, No. 2. Price R. 1-8 or 2*s*.	F. R. Parnell, B.A., Ag. Dip (Cantab), Government Economic Botanist, Madras; G. N. Rangaswami Ayyangar, B.A., and K. Ramiah, L.Ag., Assistants in Economic Botany.	Messrs. Thacker Spink & Co., Calcutta.
135	Studies in Indian Sugarcanes No. 3. The classification of Indian canes with special reference to the Saretha and Sunnabille groups. Memoirs of the Department of Agriculture in India, Botanical Series. Vol. IX, No. 4. Price Rs. 2-4 or 3*s*.	C. A. Barber, C.I.E., Sc.D., Government Sugarcane Expert, Madras.	Ditto.
136	Plant Types for College Students. Price R. 1-8.	Father Ethelbert Blatter, S. J. Professor of Botany, St. Xavier's College, Bombay.	.....

List of Agricultural Publications in India during 1917-18—contd.

No.	Title	Author	Where published
	MYCOLOGY.		
137	*Orobanche* as a Parasite in Bihar. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. IX, No. 3. Price R. 1 or 1*s.* 6*d.*	F. J. F. Shaw, D.SC. (LOND)., A.R.C.S., F.L.S., Second Imperial Mycologist.	Messrs. Thacker Spink & Co., Calcutta.
138	Proceedings of the Mycological Conference held at Pusa on the 5th February 1917 and following days. Price As. 2 or 2*d.*	Imperial Mycologist, Agricultural Research Institute, Pusa.	Government Printing, India, Calcutta.
139	Fungi and Disease in Plants. Price Rs. 15.	E. J. Butler, M.B., F.L.S., Imperial Mycologist, Pusa.	Messrs. Thacker Spink & Co., Calcutta.
140	Smuts of Jowar (*Sorghum*) in the Bombay Presidency. Bulletin No. 78 of the Pusa Agricultural Research Institute. Price As. 4 or 5*d.*	G. S. Kulkarni, L.AG., Assistant Mycologist, Department of Agriculture, Bombay.	Government Printing, India, Calcutta.
141	Spike Disease of Sandal. Mysore Department of Agriculture Bulletin No. 3 (Mycological Series).	Issued by the Mysore Department of Agriculture.	Government Press, Bangalore.
	ENTOMOLOGY.		
142	The Indian Sugarcane Leaf hopper (*Pyrilla aberrans*, Kirby). Memoirs of the Department of Agriculture in India, Entomological Series, Vol. V, No. 2. Price Rs. 2 or 3*s.*	C. S. Misra, B.A., First Assistant to the Imperial Entomologist.	Messrs. Thacker Spink & Co., Calcutta.
143	Report on a Collection of Termites from India. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. V, No. 3. Price R. 1 or 1*s.* 6*d.*	Karin and Nils Holmgren, Hogskolas Zootomiska Institute, Stockholm. Translated by T. Bainbrigge Fletcher, R. N. F.L.S., F.E.S., F.Z.S., Imperial Entomologist, Pusa.	Ditto.
144	On a Collection of Sphecoidea sent by the Agricultural Research Institute, Pusa, Bihar. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. V, No. 4. Price As. 12 or 1*s.*	Rowland E. Turner, F.Z.S., F.E.S.	Ditto.

List of Agricultural Publications in India during 1917-18—contd.

No.	Title	Author	Where published
	ENTOMOLOGY—contd.		
145	Report of the Proceedings of the Second Entomological Meeting held at Pusa on the 5th to 12th February 1917. Price Rs. 3 or 4*s.* 6*d.*	T. Bainbrigge Fletcher, R.N., F.E.S., F.L.S., F.Z.S., Imperial Entomologist.	Government Printing, India, Calcutta.
146	Second Report on the Experiments carried out at Pusa to improve the Mulbery Silk Industry, compiled under the direction of the Imperial Entomologist, Pusa. Bulletin No. 74 of the Pusa Agricultural Research Institute. Price As. 4 or 5*d.*	M. N. De, Sericultural Assistant, Pusa.	Ditto.
147	Anatomy of Silkworm and Moth. Price As. 6.	M. N. De, Sericultural Assistant, Pusa.	Grihastha Publishing House, Calcutta.
148	Instructions for Reporting Insect Damages and Forwarding Specimens for Examination. Madras Department of Agriculture Leaflet No. 1 of 1918.	T. V. Ramakrishna Ayyar, B.A., F.E.S., F.Z.S.	Government Press, Madras.
149	The Insect Pests of Tobacco in Southern India. Madras Department of Agriculture Leaflet No. 2 of 1918.	Ditto.	Ditto.
	VETERINARY.		
150	Annual Report of the Imperial Bacteriologist, Muktesar Laboratories, for the year ending 31st March, 1917. Price As. 5 or 6*d.*	Issued by the Agricultural Adviser to the Government of India, Pusa.	Government Printing, India, Calcutta.
151	The Vitality of the Rinderpest Virus outside the Animal Body under Natural Conditions. Memoirs of the Department of Agriculture in India, Veterinary Series, Vol. III, No. 1. Price As. 12 or 1*s.*	A. W. Shilston, M.R.C.V.S., Assistant Bacteriologist, Muktesar Laboratory.	Messrs. Thacker Spink and Co., Calcutta.
152	A Note on Jhooling in Camels. Bulletin No. 72 of the Pusa Agricultural Research Institute. Price As. 2 or 3*d.*	H. E. Cross, M.R.C.V.S., D.V.H., A.Sc., Camel Specialist, Sohawa.	Government Printing, India, Calcutta.

List of Agricultural Publications in India during 1917-18—contd.

No.	Title	Author	Where published
	VETERINARY—contd.		
153	Experiments with Emulsions for Protecting Camels against the Attacks of Blood-sucking Flies. Bulletin No. 76 of the Pusa Agricultural Research Institute. Price As. 2 or 3*d*.	H. E., Cross, M.R.C.V.S., D.V.H., A.Sc., Camel Specialist, Sohawa.	Government Printing, India, Calcutta.
154	Some Camel-feeding Experiments. Bulletin No. 77 of the Pusa Agricultural Research Institute. Price As. 2 or 3*d*.	Ditto.	Ditto.
155	Statistics compiled by the Government of India from the Reports of Provincial Veterinary Departments for the year 1916-17.	Issued by the Revenue and Agricultural Department of the Government of India.	G. M. Press, Simla.
156	Annual Report of the Bengal Veterinary College and of the Civil Veterinary Department, Bengal, for 1916-17. Price As. 9 or 10*d*.	Issued by the Civil Veterinary Department, Bengal.	Bengal Secretariat Book Depot, Calcutta.
157	Annual Report of the Civil Veterinary Department, Bihar and Orissa, for 1917-18. Price As. 8 or 8*d*.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bihar and Orissa, Patna.
158	Parasitic Diarrhœa of Ruminants. Bihar and Orissa Veterinary Pamphlet No. 1 of 1918.	Ditto.	Ditto.
159	Annual Report of the United Provinces Civil Veterinary Department for the year ending 31st March 1918. Price As. 8 or 9*d*.	Issued by the Department of Agriculture, United Provinces.	Government Press, United Provinces, Allahabad.
160	Annual Report on the Punjab Veterinary College, Civil Veterinary Department, Punjab, and the Government Cattle Farm, Hissar, for 1916-17. Price As. 8 or 9*d*.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
161	Report of the Bombay Veterinary College and Civil Veterinary Department, Bombay Presidency including Sind, for 1916-17. Price As. 7 or 8*d*.	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.

List of Agricultural Publications in India during 1917-18—concld.

No.	Title	Author	Where published
	VETERINARY—concld.		
162	Annual Administration Report of the Civil Veterinary Department, Madras Presidency, for 1916-17. Price As. 8 or 9*d*.	Issued by the Civil Veterinary Department, Madras.	Government Press, Madras.
163	Report on the Working of the Civil Veterinary Department, Central Provinces and Berar, for 1916-17. Price R. 1 or 1*s*. 6*d*.	Issued by the Department of Agriculture, Central Provinces and Berar.	Government Press, Central Provinces, Nagpur.
164	Report of the Civil Veterinary Department (including the Insein Veterinary School), Burma for the year ending 31*st* March 1917. Price As. 8 or 9*d*.	Issued by the Civil Veterinary Department, Burma.	Government Printing, Burma, Rangoon.
165	Report of the Civil Veterinary Department, Assam, for 1916-17. Price As. 8 or 9*d*.	Issued by the Department of Agriculture, Assam.	Assam Secretariat Printing Office, Shillong.

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